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UTILIZATION OF RESEARCH IN THE BRITISH COMMONWEALTH

A RESOLUTION passed at the British Commonwealth Scientific Official Conference in 1946 recommended the preparation of a report on the methods for promoting the application of research carried out under government auspices which had proved successful in the countries of the Commonwealth. This arose out of the realization that what was of first importance for Great Britain in particular was not the general expansion of research but the more effective utilization of existing knowledge. Following Sir Henry Tizard's emphasis on the point in his presidential address to the British Association in 1948, the problem has been regarded as one of increasing urgency and has been considered both by the Parliamentary and Scientific Committee and the Advisory Council on Scientific Policy. It has also received some comment in the reports of the productivity teams which visited the United States under the auspices of the Anglo-American Productivity Council.

In spite of this, a draft report in implementation of the recommendation of the Scientific Official Conference was only presented to the British Commonwealth Scientific Conference held in Australia early in 1952, instead of in December 1947, as originally recommended. The draft report was endorsed by the Conference, and it has now been brought up to date to the end of 1953 and published* ; it also includes a brief reference to the survey of the relations between industry and science in the Greater Manchester area carried out by the Manchester Joint Research Council, so far as it bears on the problem, issued only in April last. All but forty of the two hundred pages of a well-produced volume are occupied by a series of factual accounts of the means at present used in the United Kingdom, in Canada, in Australia, in New Zealand, in South Africa, in India, in Ceylon and in Southern Rhodesia for securing the rapid translation of research results into practice. A further appendix describes methods used in the United States by the Tennessee Valley Authority, the Bureau of Agricultural and Industrial Chemistry of the United States Department of Agriculture and the Research Corporation and University Research Foundations.

These factual accounts are clearly presented and, on the whole, are adequate; though, seeing that most of the information was reasonably accessible, the time-lag seems inexplicable. Where the book is inadequate is in the three chapters reviewing the methods by which the results of scientific research are normally communicated, supplementary methods, and obstacles to the use of information. These chapters fail so completely to provide the critical analysis required that the conclusions which follow likewise fail to get to the heart of the problem ; indeed, the book makes practically no contribution to the question what are the forces and motives which

* The Application of Results of Research. Compiled and Edited by Vera Connell, in collaboration with the British Commonwealth Scientific Offices (London). (British Commonwealth Scientific Conference.) Pp. vii+212. (London : Butterworths Scientific Publications; New York : Academic Press, Inc., 1954.) 21*s.* net.

retard or stimulate commercial development. It takes us no further than the discussion on the subject nearly three years ago at the International Symposium on the Organization of Scientific Research sponsored by the Department of Scientific and Industrial Research. Far more searching and relevant to present needs are the comments in the Comparative Study of Applied Research in Europe, the United States and Canada, published as Vol. 1 of the report of three Technical Assistance Missions of the Organization for European Economic Co-operation the substance of which, with two related volumes, was noticed in *Nature* of October 23, p. 778.

Nevertheless, it is worth looking a little more closely at the chapters on the communication of the results of scientific research in the volume arising out of the British Commonwealth Scientific Conference of 1946. The book is concerned primarily with the utilization of the results of research carried out under government auspices and, quite apart from the increasing extent to which both fundamental and applied research depend on government support, the shortcomings of the book may perhaps give a clue to some of the real causes of failure to secure effective development, or even to the real weaknesses in government-sponsored research. At least the complacency with which the adequacy of the existing arrangements is taken for granted should be challenged. When, for example, Sir Cyril Hinshelwood can write, as chairman of the Fuel Research Board, "On the basis of existing knowledge, and with no undue capital expenditure, the same amount of useful heat and power as are now obtained could be achieved with a saving over the country as a whole of several millions of tons of coal a year", it is time to examine not merely the receptivity of firms to scientific and technical information, but also the appropriateness of the way in which it is presented. We cannot assume that the multiplication of reports and scientific or technical papers, of liaison officers and the like will of itself achieve the object. The much more searching question of their appropriateness to their purpose must be asked.

On that point this report has little or nothing to say. As to whether reports or scientific and technical papers are actually read and understood by those to whom they are distributed, no evidence is offered. The validity of the existing methods of dissemination are taken for granted in the assumption that intensification or multiplication is all that is required. Yet the essential factor is the difference between securing the utilization or development of knowledge acquired as a result of some piece of investigation conducted or instituted by the firm itself, and the utilization of knowledge acquired from outside without its own effort. We cannot even assume that the latter process is parallel with the dissemination of scientific knowledge to scientists or technologists in general.

It is the psychological factor that is important and, however effective methods of overcoming it may prove, its existence is a reason for regarding with some reserve the tendency for the State to assume increasing financial responsibility for industrial research and especially technical development. The selection of industrial research objectives can scarcely be as sound from outside as from within a firm, and from those two points of view alone the utilization of research results is more likely to be encouraged by a government policy which encourages initiative and enterprise by the individual firm than by actual government sponsoring of research and development. Indeed, it might well be asked if a sound move to counter the prevailing sluggishness would not be a fiscal policy which ceased to bolster up the inefficient firm and forced it out of existence.

Sir Henry Tizard has not concealed his own uneasiness as to the rigidity of British industry and the dangers of relying on government initiative and support where development is concerned, if not also in regard to research. Moreover, where industry is lacking in the spirit of adventure and in receptivity to new ideas, it is unlikely that such a defect will be corrected from the government side. In the Civil Service such defects are commonly accepted as part of the price to be paid for its virtues and excellences. It will be noted that, while the report records some of the activities, such as investigations into the rate of technological innovation, which have been initiated by the Committee on Human Relations in Industry with funds from the Conditional Aid Programme, it shows no appreciation of the urgency and importance of this work, if the obstacles to innovation and development are to be overcome.

Such inquiries as are now being sponsored by the Committee on Human Relations in Industry may well indicate ways and means for dealing more effectively with human obstacles to the introduction of new production techniques and methods and to new processes and products. Simultaneously, however, the whole climate of industrial research and development in Great Britain requires examination in relation to the application of existing knowledge. There is room for more factual inquiry on questions which are commonly matters of opinion, as was recently pointed out in these columns (see *Nature*, **174**, 145; 1954); and the effectiveness of existing means of communicating knowledge should be no more immune from such inquiry than the relevance and appropriateness of the knowledge communicated, or the ability and competence, as well as the receptivity, of those to whom it is supplied.

Admittedly, some such inquiries go outside the scope of the report contemplated by the British Commonwealth Scientific Official Conference in 1946: but none the less, any critical appraisal of existing methods of promoting the utilization of research results should have at least indicated the bearing of such factors on the application of existing knowledge and technological innovation. It should also have examined the appropriateness of existing practice, and considered whether or not some of the effort could not be better expended in other directions or on new methods. It should not be assumed as axiomatic, as this report appears to do, that all the existing effort given to the communication of research results is necessarily effective and worth while. Even if industry does need to employ more scientists and

technologists at all levels, it no more follows that industry is being supplied with the information it most needs in the most appropriate way, or that all the existing information services should be maintained or expanded, than it follows that thereby the more fundamental psychological, economic or fiscal obstacles to innovation will be removed.

The report does not, it is true, overstress the part which methods of communication play in furthering the application of the results of research; but it does not seriously question the suitability of methods of distributing scientific and technical knowledge to the right places for utilization. "Information obtained through research represents in the aggregate very large expenditures of money and of the time, energy and intelligence of all-too-scarce trained men. Failure to make the fullest use of this effort is a flagrant waste which no country can afford. The responsibility for minimizing this waste must be shared by industry and research organizations. Management and labour must be receptive, and those responsible for research organizations must accept, as one of their primary duties, the task of ensuring that there is no waste of information through their default or neglect."

This, concludes the report, should be a cardinal point of policy, and it adds, "To give effect to it requires conviction of its necessity, continuous and close attention to its operation, imaginative but realistic choice of the methods to be used and persistence in their application". Nevertheless, no hint is given that this is exactly what is required of those actually engaged in the task of communication, and that the technique of communication and the trained man-power devoted to it are as appropriate a subject for scrutiny as the disposition of trained man-power in industry and in government service generally. The very fact that industry is already in fierce competition with the universities, with government departments and with the schools for the present supply of scientists makes it essential that such scientists should be wisely and effectively used, and not employed on duties which could be equally well performed by less highly trained persons.

Any such scrutiny of the use made of scientists in industry must include their use in information and like services, as well as in research. We should be as careful to satisfy ourselves that scientists are only employed in information work when their scientific qualifications are really essential, as will often obtain, as to ensure that industrial research is directed to objectives that are worth while; and neither duplicates what is being done elsewhere or is being pursued in fields unlikely to yield returns commensurate with the effort. What has to be realized is that every scientist engaged in such activities is one less available for the myriad other tasks involved in technological development, that each information officer or liaison officer employed on a non-essential task means one less available elsewhere, either for some essential part in winning the confidence of industry, in interpretation, or in training the fresh scientists and technologists that industry still needs.

All this is emphasized by even the limited comparative study of the organization of applied research in Europe and the United States and Canada made for the Organization for European Economic Co-operation. Most countries, it is clear, would benefit from an expansion of their research effort and from a close scrutiny of their policy with regard to research staff and their arrangements for co-operation, co-ordination and the exchange of information. Everywhere the critical factors are the shortage of qualified workers and their most effective use, and the inadequacy of allocations for research, and, especially in Europe, for the commercial application of the results.

Greater efforts in all countries, and also internationally, are recommended to ensure the more effective communication of research results and technique, and far more stress is laid in these reports than in that presented to the Commonwealth Scientific Conference on the importance of the personality of the liaison officer in the increasingly active industrial liaison service which is recommended. While once again it is emphasized that there is no lack of quality in European research, conditions in the United States are generally more favourable for applied research and industrial innovation. What is needed in Europe is a more frankly commercial initiative on the part of the applied scientist, and more direct support and recognition of the production and profit potentialities by industry and government.

Though there is much in these reports which repeats what has frequently been said in discussions on scientific and industrial research in Great Britain during the past ten years—the principles commended in the chapter on the research climate in the United States and Europe, for example, have been pressed in these columns for even longer—they make a number of suggestions, adoption of which might well help Britain to foster the enthusiasm for research which gives the United States so marked an advantage. We have still, for example, to formulate an adequate national research policy with the appropriate balance between fundamental and applied research, and scientists are reminded that when their work receives little attention and appropriations are not forthcoming, the fault may be partly their own failure to make full use of their opportunities for stating their opinions or selecting research projects of sufficient scientific or economic importance. Again, the need is emphasized for a constant review of the work and growth of government research organizations, and research councils are recommended to make a determined effort to collect and analyse data on investment in industrial research and development. A study is also recommended of the possibilities of minimizing the deterrent effects of taxation and encouraging both the commercial exploitation of research and the appropriation of funds for research.

What emerges particularly from this study is that for each country the organization and encouragement of applied research present a challenge to imaginative enterprise and to constructive thought. There is no general solution to the problems, however much the experience of other countries may assist any par-

ticular country in working out a pattern and solution appropriate to its own needs and conditions. Forms of co-operation even may differ, and while in the United States, for example, sponsored research institutes are already well established and the co-operative research association finds no favour, the situation varies considerably in Europe, where the field for sponsored research institutes depends on the extent and efficiency with which industry and government meet the requirements for research. No wholly satisfactory solution to the research needs of the small firm has yet been found; but on the other hand, the factors responsible for a satisfactory research climate are well understood and valid generally. The reports of these Technical Assistance Missions are well calculated to dispel any complacency engendered by that submitted to the Commonwealth Scientific Conference. Even in regard to documentation and the communication of results, they call for a critical review of existing methods and for active attempts to improve the means of communicating research results to industry; and the research worker himself is summoned to take part in this work. In particular, he is urged to examine the form in which information is supplied to him and, where appropriate, to indicate and press for better means. No scientist who reads the reports of these Missions is left in any doubt as to the importance of the contribution which he has to make, both personally and through his professional associations, to the constructive thinking and critical scrutiny of our whole organization for scientific and industrial research and for the means of disseminating the results of its activities. That thinking and scrutiny must precede alike the formulation of an adequate national research policy, and the devising of appropriate measures both to foster a real research climate and to overcome the obstacles, whether fiscal, psychological or technical, which hinder technological innovation in industry.

ANALYSES OF MARINE ORGANISMS

The Elementary Chemical Composition of Marine Organisms

By A. P. Vinogradov. (Memoir No. 2.) (Translated from the Russian by Julia Efron and Jane K. Setlow, with Bibliography by Virginia W. Odum.) Pp. xiv+647. (New Haven, Conn.: Sears Foundation for Marine Research, Yale University, 1953.) 17 dollars.

THOUGH less than one-half per cent of the organisms that live in the sea have been submitted to any kind of elementary chemical analysis, much has been done. Analyses have become buried in a mountain range of journals, many highly inaccessible. There has been no means by which a research worker in a reasonable time could find what has been done in his own field. Full assessment of the part played by marine organisms in geochemistry has been impossible.

As part of the programme of Prof. V. I. Vernadsky's Biogeochemical Laboratory of the Academy of Sciences, Moscow, Prof. A. P. Vinogradov undertook the exceedingly onerous task of collecting and assessing this literature. He has published the results in the *Travaux* of that Laboratory in three parts in 1935, 1937 and 1944. These included much fresh and accurate analytical work from Russian laboratories by Vernadsky, Vinogradov and their school. Of these Russian publications, very few copies are available to the Western world. The reviewer knows of no accessible copy of the 1944 part in the British Isles.

The translation of this unique work into the English language has resulted from a happy Russo-American collaboration under the ægis of the American Museum of Natural History and the Sears Foundation of Marine Research. It is not a word-by-word translation by hacks but really a new work. The additions of the 1944 part were incorporated as appropriate in the earlier parts. The whole English translation was then seen by Vinogradov, who added new and unpublished material and made corrections. Still more recent material was added during editing and preparation for the press. There are also many helpful footnote commentaries by the translators. The bibliography of about 2,500 entries is essentially new and adds greatly to the value of the work for the advancement of geochemistry, marine biochemistry and systematics, oceanography, as well as of industrial biology and the science of petroleum.

One chapter is devoted to each phylum and may occupy 100 pages or less than one. For phyla much investigated such as algae, molluscs and fishes, the chapters are broken down into sections dealing either with single chemical elements or with single families. Owing to the difficulty of removing extraneous salt from the marine organism there has been much confusion in the meaning of such basic terms as 'wet weight'. Vinogradov has made order out of chaos, and future analysts of marine organisms would be wise to model their procedure to fit his classification.

The language of such a compilation is always likely to be repetitive, stilted and dull. In fact, this work is none of these, but has literary merit and holds attention by well-marshalled presentation and attractive writing. The technical production is superb and, in a book which will long retain scientific value, may be justified. However, in spite of heavy subsidy from the American Museum of Natural History and the Sears Foundation of Marine Research and the financial advantages of printing in Denmark, its price is so high as to place it beyond the means of most individuals outside the United States. Many would forgo the pleasure of consulting a collector's piece in a wealthy library for the advantage of themselves possessing a shoddier edition of an essential working tool. The cost of essential books which should be in a research worker's personal library is ever rising. Is there a case for again pressing on the Board of Inland Revenue, perhaps in the debates on the Finance Bill, the view that such costs are properly chargeable as personal expenses against taxation?

This book is as complete as any work of man is ever likely to be, but it cannot remain so. In a few years supplements will be needed, perhaps to the 327 tables with their numbers unchanged. It is to be hoped that the Biogeochemical Laboratory of the Russian Academy of Sciences, the American Museum of Natural History and the Sears Foundation may be able to achieve the preparation and publication in Russian and English of such supplements.

L. H. N. Cooper

THE RAW MATERIAL IN FOOD PRODUCTION

Soil

By G. V. Jacks. (Nelson's Agricultural Series.) Pp. ix+222+10 plates. (Edinburgh and London: Thomas Nelson and Sons, Ltd., 1954.) 12*s*. 6*d*. net.

THE problem of food supply will always be with us; it will not be solved by pretending it does not exist; it can be properly approached only through some knowledge of the soil, which is the basis of all agricultural pursuits. The brown or grey surface layer of the fields—the 'earth' to the uninitiated—is but the visible sign of an ageless development of soil, in the genesis of which parent material, climate, vegetation, topography and time are the factors inextricably related and on which man can finally exert an influence that may completely upset for good or ill the slow change of centuries.

What is soil in its origin, physical and chemical properties, fertility, utilization? These are the questions that are dealt with in this book, the fifteenth in the Nelson Series for farmers and students of agriculture, and one that could also be profitably read by any others seriously interested in the question of food production. As becomes a writer with an enviable reputation and a wide knowledge of his subject, the text carries the stamp of authority; it is a straightforward statement in plain English of what we know and what we do not know, with the emphasis on general principles and the interplay of factors. Mr. Jacks has, in fact, most ably achieved his aim of presenting an interpretation of the scientific facts in language comprehensible to the non-specialist reader.

He has taken soil structure as the all-important measure of fertility, for it is upon structure that aeration, water absorption and movement and, consequently, the growth and health of the plant depend; a good soil is a complex and balanced biological medium adequate for those micro-organisms that assist in all the physical and chemical changes concerned in nutrition. To understand what is meant by structure requires some comprehension of the forces that have produced the complete picture or profile upon which the fundamental systems of classification have been based. The relationship between genetic classification and productivity ratings is not always precise, but soil science is young and practical applications have so far outstripped fundamental studies. Hence, although the successful renovation of worn-out grasslands and rehabilitation of sea-flooded areas, for example, are based upon well-established principles in soil chemistry and physics, the reasons for the build-up or break-down of the mineral–organic aggregates or stable crumbs of a fertile soil are still somewhat speculative, and it is here that wrong management, quite as much as mismanagement, has assisted the erosion forces of Nature and where conservation services—but not nearly enough of them—are striving to redress the balance.

The author constantly stresses the relative stability of the 'plant-made' soil in contrast to that of the 'man-made' soil. That the latter may become many times more productive in certain situations is the result of the system of agriculture established through trial and error and the sensible adoption of modern aids in the form of better machines, better varieties and the fertilizers to improve and maintain fertility.

The well-chosen plates illustrate clearly the points in the text dealing with soil formation, structure, microbiology and conservation, and there is a short bibliography. One might criticize an occasional looseness in the nomenclature relating to nutrients, and there is an obvious slip at the top of p. 60; but the book is all but free of printing errors and is very well produced.

A. M. SMITH

TISSUE CULTURE

The Cultivation of Animal and Plant Cells

By Philip R. White. Pp. xii+239. (New York: The Ronald Press Company, 1954.) 6 dollars.

THE foreword states that this book was written with three objects: to describe the major techniques of plant and animal tissue culture in sufficient detail to enable them to be used in research, to present a group of simple methods suitable for teaching purposes and to emphasize "the essential importance of the cell itself, as the basic physiological entity".

While it is probable that few people can master an intricate technique like tissue culture merely by studying a book on the subject, it is very valuable to have the methods of leading experts recorded for the benefit of other workers in the field.

The book begins on a philosophical note with a discussion of the relationship of the cell to the organism. This is followed by an account of the history of cell culture, and in this connexion an interesting chart is provided tracing the various lines along which tissue culture has developed. It is unfortunate that the name of T. S. P. Strangeways is omitted from this summary, since he was one of the pioneers of the method in Europe and wrote two of the earliest books on the subject. The author deals next with the many different types of plant and animal cells that can now be grown *in vitro* and then proceeds to describe the tissue culture laboratory, its equipment, and routine procedures such as washing glassware and sterilization; succeeding chapters are devoted to nutrients and the preparation of various types of cultures. As he tells us in his foreword, Dr. White has been animated by the laudable ambition "to strip from the study of this subject [cell culture] its former atmosphere of mystery and complication", and the procedures he advocates are not unduly elaborate.

The difficult and controversial questions of how to measure growth and how to interpret the quantitative results obtained are considered at some length, and it is wisely emphasized that the observer must "take into account not merely the numerical data but also many qualitative features of the results which cannot be set down in numerical form". The last chapter, which deals with the various ways in which tissue culture can be applied in different medical and biological fields, is perhaps the most stimulating. In the reviewer's experience, so much attention is sometimes paid to developing and polishing the method that this tends to become an end in itself; it is therefore important to stress the fact that tissue culture is merely a technique, and useful only in so far as it is applied to the solution of biological problems.

Finally, there is an appendix in which are described some fairly simple experiments for beginners; an

attempt has been made "to choose examples which are as simple as possible, so that they will not be beyond the means of small schools". This section should be useful for those wishing to organize courses in experimental biology for senior students.

A minor defect of the book is the considerable number of verbal slips which are encountered; for example, 'serum' when 'plasma' is meant (p. 200). The work can be recommended, however, as a clear and interesting account of some valuable methods; the more solid matter is enlivened here and there by some delightful quotations from ancient authors, which serve as texts for some of the chapters.

Honor B. Fell

BELOW 1° K.

Magnetic Cooling

By C. G. B. Garrett. (Harvard Monographs on Applied Science, No. 4.) Pp. xi+110. (Cambridge, Mass.: Harvard University Press; New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1954.) 36*s*. net.

JUST over twenty years have elapsed since the temperature region below 1° K. was opened by the adiabatic magnetization of paramagnetic salts. Except for the war years there has been a steady increase in the work in this field, and the stage has now been reached where magnetic cooling is becoming a standard technique in many cryogenic laboratories. Comparing the progress of the magnetic cooling method with the state of gas liquefaction two decades after Cailletet and Pictet, there exists a strong resemblance which is reflected in Dr. Garrett's book. Now, just as then, the physical properties of the cooling agent completely hold the stage. Dr. Garrett is as preoccupied with the susceptibility of paramagnetic salts as the low-temperature physicists of the nineties were with the equation of state. The result is that his book seems a little out of balance, which is particularly noticeable in a short monograph of only 105 pages length. Detailed discussion of the paramagnetic phenomena is, at the present stage of development of magnetic cooling, certainly justified, but this means that "other experiments" had to be dealt with in eighteen pages. Rather more serious is the summary way in which the whole of demagnetization technique is treated in only eight pages. The sealed capsule method, for example, is not mentioned here at all. Description of experiments admittedly lacks the glamour of the theoretical discourse, but a monograph in applied science could have afforded slightly more space for technicalities at a time when the magnetic cooling method is being taken up by more and more laboratories.

While one may criticize the choice of balance in the book, it should be emphasized that the material has been treated competently and with clarity. The chapter on technique is followed by one on thermodynamic relations and one on the magnetic temperature scale. The following three chapters deal with the theory of paramagnetism at low temperatures, with the results of specific heats and susceptibilities for a number of salts and finally with co-operative effects. This section with its extensive set of references to original work will be found most useful by those who work in the field of adiabatic demagnetization or who are entering on it. A closing chapter gives a short survey of the use to which paramagnetic cooling has been put, such as investigations on liquid helium and on superconductors. Multi-stage demagnetization and nuclear alignment also receive here a short mention.

Subject to its limitations, the book will be of interest to most low-temperature physicists and to students specializing in either cryogenics or magnetism. It is unfortunate that the price will put it out of the reach of many of the latter.

K. Mendelssohn

SCINTILLATION COUNTERS AND PHOSPHORS

Scintillation Counters

By Prof. J. B. Birks. (Pergamon Science Series: Electronics and Waves.) Pp. viii+148+4 plates. (London: Pergamon Press, Ltd., 1953.) 21*s*.

THE development of scintillation counters in the past seven years is one of the most rapid contemporary advances in the techniques of nuclear physics, and Prof. J. B. Birks's book gives a timely summary of this recent work and a picture of the present state of the art.

The subject of these instruments is dealt with, not only from the point of view of those who wish to use them as tools, but also of those who are interested in the properties of the phosphors themselves. The author follows a logical sequence beginning with a brief but adequate summary of the principles of scintillation counting; this is followed by a discussion of photomultiplier tubes and data on the commercially available types. Measurements of instrumental resolution are then considered, and the next three chapters are devoted to descriptions of the various types of phosphors. The final section is a survey of some applications of scintillation counters.

Prof. Birks's main interest has been the study of organic crystalline phosphors, and the section on these materials forms the longest single chapter in the book. This is a comprehensive account including results of recent work by the author, and his interpretation of these results in terms of the 'photon exchange' process which he has proposed as an alternative theory to the 'exciton migration' process as a mechanism of energy transfer in mixed crystals. One wonders whether a monograph, particularly with the present title, is the best place for the detailed presentation of such a theory, at least until there is general agreement on its tenets. As one concerned with the use of counters, the reviewer would have preferred to see a greater proportion of the space devoted to discussion of problems likely to arise in the applications of the instruments. For example, to anyone wishing to use the fast response of these counters to their best advantage, a fuller indication of the circuit problems met with in the millimicrosecond region would be a welcome addition. A description of experimental methods of crystal production would also be useful.

Prof. Birks has, however, written a very readable book and he has included a good bibliography which will be useful to the reader interested in further experimental details.

The publishers are to be congratulated upon the speed with which the book was produced, an essential requirement for a monograph in a rapidly developing subject: very few misprints occur, and the diagrams and type are pleasing.

A. R. Cruthorn

DISTRIBUTION OF MINOR ELEMENTS IN ROCKS

RESEARCH on the geochemistry of the rarer elements was given a real impetus in the 1930's by the investigations of the late V. M. Goldschmidt and his co-workers. Progress at that time was due, in the main, to the introduction and application of sensitive methods of instrumental analysis. Except for the period of the war years, interest and investigation on the geochemistry of the rare elements has continued to grow, and the recent discussion at Oxford arranged by Section C (Geology) of the British Association reflected in several respects the progress which has been made during the past few years. The programme of speakers and discussion was arranged so as to cover the distribution of minor elements in a broad way, starting with aspects of cosmochemistry and followed by consideration of minor element behaviour of igneous rock series, sedimentary rocks and finally metamorphic rocks. In his introductory remarks, the chairman, Prof. L. R. Wager (University of Oxford), pointed out that once geochemical patterns of minor element behaviour were firmly established for known conditions—as, for example, in fractionated rock sequences—they could no doubt be used in solving more complex geological problems of rock genesis where processes are less clear.

Dr. L. H. Ahrens (University of Oxford) directed attention to the general qualitative similarity of composition of various materials composing the observable universe. He pointed out, however, that it is only the earth and the meteorites which can be sampled directly and are capable, therefore, of precise quantitative investigation: this opens up the possibility of testing exact quantitative equivalence of composition. Evidence of such equivalence would be of geochemical, geophysical, petrological and nuclear-physical significance. Tests could be carried out by examining pairs or larger groups of elements, provided they show a high degree of geochemical coherence: zirconium–hafnium; niobium–tantalum; some rare earths and potassium–rubidium were cited as possibilities. Adequate data are available only for the pair of alkali metals, and their association in the commonest rocks and meteorites were discussed in detail. Earlier investigations of Ahrens, Pinson and Kearns[1] indicated that the ratio potassium/rubidium remains uniform throughout the principal types of rock and is very similar or possibly equal to that in chondrites, the commonest meteorites. Their observations were restricted mainly to North American rocks, and evidence from other sources was therefore desirable. Some seventy new determinations, mainly on igneous rocks from South Africa, have since been made and all observations are represented in Fig. 1. The close association of potassium and rubidium in rocks and meteorites is evident, and calculation shows that the ratios of potassium to rubidium for rocks and chondrites are equal to within about 5 per cent. Dr. Ahrens pointed out that as neither element is a participant of either metal or sulphide phases, it can be concluded similarly that the ratio of potassium to rubidium for the earth is equal to that for meteorites $\pm$ 5 per cent. This is the first, and so far only, example of its kind and has been taken as evidence in support of a common origin for the earth and meteorites. This information does not, however, appear to be of use with regard to the problem of two possible origins of the meteorites—either from a shattered planet or from a collision of asteroids. It is desirable that similar research be carried out on other possible pairs or groups of elements. Sir Edward Bailey commented on the analogy between the ratio of potassium to rubidium and the ratios of various isotopes of different elements in the earth and meteorites which observation has shown to remain uniform. Prof. Wager and Dr. M. H. Hey commented on the fact that Dr. Ahrens's data apparently show that different parts of the earth may be characterized by slight but significant differences in their potassium–rubidium ratio and that this is perhaps the first and only reliable indication of any fundamental regional differences.

Dr. S. R. Nockolds (University of Cambridge) described some of the results of recent research at Cambridge. The principal objects of these investigations were to examine the behaviour of trace elements with respect to the major constituent elements in some well-described igneous rock series of calc–alkali, alkali and tholeiitic character: to determine how their behaviour varied from series to

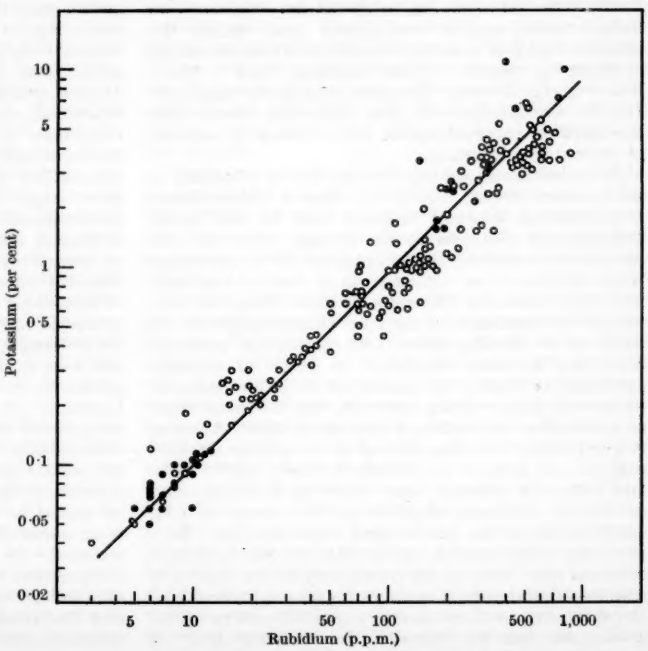

Fig. 1

series and from group to group and to see what light, if any, they might throw on the origin of the three main branches of igneous rock evolution. Particular attention was given to the calc–alkali and alkali groups, which were represented as follows: (calc–alkali) southern California batholith, the Scottish Caledonian and lavas of Lassen Peak, Crater Lake, Lesser Antilles, the Medicine Lake Highlands and Sierra Nevada; (alkali) Scottish Tertiary, Hawaiian alkali rocks, Polynesian alkali series, and the latite series of Sierra Nevada.

Discussion was confined to lithium, chromium, nickel, cobalt, iron and vanadium, some data on which have already been published[2,3]. For the purpose of demonstrating behaviour, the concentration of each element is related (as ordinate) to the function $[(\frac{1}{3}\mathrm{Si} + \mathrm{K}) - (\mathrm{Ca} + \mathrm{Mg})]$, as suggested by Larsen. The characteristic behaviour of chromium and nickel—a regular and sometimes sharp decrease of concentration with increase in acidity, followed by some levelling—is clearly evident in nearly all examples of a series from each of the three groups. Iron and vanadium behave in much the same way in series of calc–alkali rocks; the concentrations of both decrease regularly with acidity. A similar behaviour is sometimes shown by iron in the alkali rocks, although the amount often remains fairly uniform over a considerable range of low $[(\frac{1}{3}\mathrm{Si} + \mathrm{K}) - (\mathrm{Ca} + \mathrm{Mg})]$ values. Vanadium, on the other hand, invariably increases with increase in the magnitude of the function, passes through a maximum and then decreases regularly with increase in the magnitude of the function. As anticipated, lithium invariably increases with decrease of $[(\frac{1}{3}\mathrm{Si} + \mathrm{K}) - (\mathrm{Ca} + \mathrm{Mg})]$ in all series from each group. Cobalt often follows magnesium, particularly in the calc–alkali rocks, and sometimes iron. Behaviour patterns in the calc–alkali series are often similar to rock series classed as belonging to the tholeiitic group. Dr. Nockolds finally directed attention to recent investigations on hybrid rocks, and it was shown that, unlike the igneous rocks of a series, variation of concentration is linear in respect to the function $[(\frac{1}{3}\mathrm{Si} + \mathrm{K}) - (\mathrm{Ca} + \mathrm{Mg})]$. During discussion of a point raised by Dr. W. Campbell-Smith, Dr. Nockolds stated that the data on the rock series are evidence in support of crystal fractionation.

In a discussion on the distribution of elements in sedimentary rocks, Dr. J. R. Butler (Rothamsted Experimental Station) referred first to the transportation of elements to the oceans, either as ions (simple or complex), as constituents of or associated with colloids, or as constituents of detrital material. The ionic potential (the ratio of ionic charge to ionic radius) of Cartledge as used by Goldschmidt can be used as a starting-point for classifying elements according to their tendency to occur in aqueous solutions as cations or anions, or to be precipitated as hydrolysates. Lead, however, can be transported as a complex ion, and in a discussion which followed it was pointed out that several of the poorly shielded cations (as defined by Ahrens[4])—Au^{+}, Hg^{2+}, Cu^{2+} and Pt^{2+}, for example—are likely to be transported as stable complexes depending, of course, on *p*H, composition of the waters and other factors. In a reducing environment, such agencies as hydrogen sulphide may bring about precipitation of a sparingly soluble sulphide (Ag_2S or Cu_2S, for example) provided the solubility product can be exceeded and provided a complex can be broken; the complex AuS^{-} is particularly stable in this respect.

The significance of cation hydration was emphasized by considering the alkali metals. Degree of hydration is determined mainly by size. It was pointed out that available evidence for the pair Cs^{+} and K^{+} (radii 1·67 and 1·33 respectively) indicates that the ratio of cæsium to potassium is greater in shale than in igneous rocks; further fully quantitative investigations are, however, required to verify this. Dr. Butler suggested that a critical examination of the cæsium to potassium ratio might prove to be helpful in the problem of the origin of glauconite. The importance of illite as a constituent of argillaceous sediments was stressed. Unlike other clay minerals, illite can provide inter-sheet structure sites of potassium for camouflage of rubidium and cæsium.

Gallium, chromium, cobalt, copper, zinc, tin, lead, zirconium and the alkali earths were discussed in addition to the alkali metals. When contrasting the abundance of gallium in igneous rocks (15 p.p.m.) with the value of 50 p.p.m. for shale, Dr. Butler pointed out that although interesting conclusions can be derived on the basis of these figures, the latter come from different sources, and as different analytical procedures have been used they are not strictly comparable. The danger of comparing data from different sources was strongly endorsed by those participating in the discussion. Available data should be used with extreme caution and there is a great need for improving the quality of future determinations.

Prof. F. J. Turner (University of California) emphasized the fact that whereas considerable data are now available on igneous rocks in particular, and sedimentary rocks to a lesser extent, quantitative data on the metamorphic rocks are conspicuously lacking. This has led to much speculation on patterns of behaviour and their possible geological significance in the metamorphic terranes. Thus, for example, Sahama[5] has observed in a reconnaissance investigation that the boron concentration in serpentine is much higher than that in parent peridotite; this suggests the action of sea water as a cause for boron enrichment, as it contains appreciable boron. Prof. Turner concluded that provided large samples are examined, departure from ideal iso-chemical metamorphism is rarely profound in the case of the common elements. It was felt, however, that concentrations of the trace elements are more likely to show large variations. He referred to the earlier reconnaissance work of Sahama[5] and Shaw[6], which indicated iso-chemical metamorphism with respect to several of the minor elements. He then considered from a theoretical point of view the possible patterns of behaviour which may be found when data become available, and dealt briefly with the only two exhaustive investigations known to him, neither of which has yet been published. The first of these is an investigation by A. E. Engel and Celeste Engel (California Institute of Technology) on progressively metamorphosed rocks of the Grenville Series in the Adirondacks, which indicates trends different from the earlier work; for not only do elements such as strontium, lead, manganese and chromium appear to be added to some beds and removed from others, even when there is no indication of general metasomatism or magmatic influence, but also isotope composition varies. The second detailed work is that of Pitcher and Sinha (Imperial College of Science and Technology, London), who have analysed several series of bulk samples taken across a pelitic hornfels formation in a contact aureole in Donegal. In

profiles of 1,500 ft. in length taken normal to the contact, the mean composition of all samples was found to remain the same. The formation had remained a closed system and there appeared to be no metasomatism; metamorphic differentiation had, however, occurred along each profile and compositional gradient had been set up.

A general impression left by the discussion on the distribution of minor elements was that most investigations nowadays involve far more analyses than heretofore; this is a healthy development. There is no doubt that a vast amount of fresh and exciting information remains to be unearthed, but real progress will only be achieved by combining quality with quantity.

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[2] Nockolds, S. R., and Allen, R., *Geochim. Cosmochim. Acta*, **4**, 105 (1953).
[3] Nockolds, S. R., and Allen, R., *Geochim. Cosmochim. Acta*, **5**, 245 (1954).
[4] Ahrens L. H., *Nature* [**174**, 644 (1954)].
[5] Sahama, Th G., *Bull. Comm. géol. Finlande*, **136**, 15 (1945).
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ANIMAL POPULATIONS AND FORESTRY

At the recent meeting in Oxford, Sections D (Zoology) and K* (Forestry) of the British Association held a combined symposium under the chairmanship of Prof. L. W. Grensted to discuss animal populations with reference to British forestry. Mr. G. H. Thompson, of the Department of Forestry, University of Oxford, opening the symposium with a general introduction, reviewed briefly some of the more important forms of injury caused by animals at different stages in the life of a forest. Insects, rabbits, squirrels, mice and voles often severely damage seed and young trees. In older forests the chief pests are insects, particularly those feeding on foliage. Conifers have a smaller capacity for regenerating lost foliage than broad-leaved trees, yet in Great Britain defoliating insects have so far killed comparatively few conifers. The British fauna includes species, such as the nun moth and pine noctuid, that are important pests of conifers on the Continent of Europe, but which in Britain have so far remained uncommon: the reason for their scarcity is unknown. The pine looper (*Bupalus piniarius* L.), although usually a common moth, first reached epidemic numbers in 1953 at Cannock Chase, completely defoliating 120 acres of Scots pine and severely attacking a much larger area. A similar attack in 1954 would almost certainly produce heavy tree mortality. Non-lethal degrees of defoliation presumably reduce growth increment, but no data exist.

Trees weakened by drought or defoliation, or unthrifty owing to unsuitable site conditions or old age, are susceptible to attack by insects such as wood-wasps and certain bark-beetles which cannot successfully oviposit in healthy vigorous trees. At Cannock Chase the defoliated pine are entered by a bark-beetle (*Myelophilus piniperda* L.), the tunnels of which in the cambium girdle and kill trees that might recover if protected from further loss of foliage. It is often hard to decide whether an insect species feeds exclusively on weakened trees, because of the difficulty of defining health.

Apart from safeguarding future vigour by choosing tree species suited to the sites to be planted, the forester may attempt to prevent or reduce animal injury by sylvicultural, biological or by chemical means. His choice of methods should be based on ecological knowledge, and in particular of those factors limiting population numbers. In fact, little is known of the population dynamics of even the more important forest pests. The science is new, and population studies are very time-consuming; the collection of data for even a dozen species of insect and three species of mammal is a formidable task. Climate, predators and parasites, and food supply are probably the chief factors influencing animal numbers. Past freedom from epidemics of coniferous defoliators may have been due to the absence of large blocks of forest of an appropriate age-class.

The application of insecticides may be justifiable to save a tree crop otherwise doomed; but, apart from the expense and impermanence of treatment, the biological implications are not fully understood, and the pest may ultimately benefit by destruction of its associated parasites and predators, or resistance to the insecticide may be developed. Forest practice should aim at keeping the injurious animal fauna below the level at which economic damage occurs by biological and sylvicultural methods; and to achieve this objective detailed knowledge is required of the factors affecting animal numbers.

Mr. F. A. Courtier, of the British Forestry Commission, described studies recently initiated to determine a satisfactory method of estimating grey squirrel populations in order that the efficacy of control measures may be assessed. A native of North America, the grey squirrel was first observed in Great Britain in 1828 and has since spread to almost every county. It is most injurious in forests, particularly to broad-leaved trees, girdling and killing stems at ground-level and also destroying leading shoots. Barking usually occurs in late spring or early summer when sap-flow is most active. There are two main breeding periods—December–January and May–June. The restricted breeding periods and relatively long time—ten weeks—spent by the young in the drey offer excellent opportunities for control.

Visual counts of adults have not given comparable results under varied woodland conditions. The relationship between the number of the breeding and the sheltering type of drey and the size of the squirrel population is being studied in mature oak woodland.

Courtier referred to estimates of population by the capture–recapture method being undertaken by Monica Shorten in an isolated wood that offers seasonal variation in food; this produces a more settled squirrel population. After intensive trapping, marking and release, the area is cleared of dreys and as many squirrels as possible are killed. Records of marked squirrels shot also provide information concerning their movements.

The squirrel population on a small area in Alice Holt forest is being studied for a period of years. Permanent trapping sites have been established. After pre-baiting for five days, trapping is conducted for four consecutive days; this procedure is repeated at intervals of six weeks. Trapped squirrels are marked and released after recording sex, weight, breeding condition, injuries and moult-stage. The squirrels show little fear of the traps and appear not

to travel far, almost all recaptures being in the original traps. Twelve nesting-boxes have recently been erected to provide information on young squirrels and their ultimate dispersal.

Mr. H. N. Southern, of the Bureau of Animal Population, University of Oxford, dealt with fundamental population studies of two of the commonest deciduous woodland rodents, the wood mouse (*Apodemus sylvaticus* L.) and the bank vole (*Clethrionomys glareolus* Schreb.). These two species probably play an important part in preventing forest regeneration, but little is known about the control of their numbers. The first step in studying this problem is to know what numbers are present and how many are born and die every year. The best available method is live-trapping. A proportion of the population is caught, marked with numbered leg-rings and released. Later, another trap sample is taken to determine the proportion of marked to unmarked animals, and so the number present at the original marking can be calculated. An extension of this method from a series of trappings also gives information on the numbers coming into and leaving the population during each interval. The statistical problems involved in this kind of calculation have been recently discussed by Chitty and Leslie, and under optimum conditions estimates should be accurate to within 10 per cent. However, serious errors may be introduced by the marked animals entering the traps more readily than the unmarked ones. This complication is still being studied.

Preliminary results from continuous trappings on 250 acres of woodland between 1948 and 1952 suggest that the trappable population of both rodents varies between 5 and 25 per acre according to season. But there are other more interesting variations. During the first year both species reached a peak in autumn; in the second year wood mice failed to reach an autumn peak; in the third year both species failed to reach an autumn peak; in the final year both species were recovering from this decline in numbers. It is interesting to note that the tawny owls (*Strix aluco* L.) which were preying on these rodents, and whose population was also being studied, showed repercussions. In the first year they preyed mostly upon wood mice; in the second year they changed to bank voles when the wood mice declined; in the third year—when both prey species were at their lowest ebb—the owls practically failed to rear any young because of food shortage.

These preliminary results illustrate the labour which will be needed to obtain a true idea of the balance of interrelationships between members of an animal community. Only when these fundamental problems are thoroughly understood will it be possible to predict, and perhaps prevent, economic catastrophes instead of resorting to *ad hoc* measures to palliate damage already done.

Dr. Myles Crooke, of the Forestry Commission, described a survey conducted in Britain during the winter of 1953–54 into the status of the pine looper (*Bupalus piniarius*) in all the State pine forests considered to be susceptible to attack. The survey was a sequel to the pine looper epidemic at Cannock Chase in 1953. The moth has an annual life-cycle: adults are in flight from May until July and the larvæ feed until October or later before descending into the litter layer to pupate. The survey was extensive in design and was based on counts of number of pupæ found in quadrats one yard square. At low populations the insects are uniformly distributed and a sampling intensity of 0·005 per cent is considered satisfactory. This is achieved by assessing five quadrats in about one out of every ten compartments in a forest. The intensity of sampling is increased when populations are high. For example, at Cannock Chase every compartment of suitable age was sampled, using as many as fifty quadrats per compartment. Four population zones were discernible: (1) defoliation complete: more than 150 pupæ per sq. yd.; (2) defoliation severe: 80–150 pupæ per sq. yd; (3) defoliation not serious: 40–80 pupæ per sq. yd.; (4) no apparent defoliation: less than 40 pupæ per sq. yd.

On the Continent of Europe, where intensive sampling over a small area is employed, the endemic population-level is considered not to exceed 0·1 pupæ per square metre: a mean of six or more pupæ per square metre carries the threat of obvious defoliation the following summer. The British survey shows that many forests exhibit considerably higher pupal counts than this. It would seem that either a much higher endemic level can be maintained under British conditions, or that pine looper populations are on the increase and epidemics similar to that at Cannock may be expected elsewhere. No underlying cause, such as recent climatic change, is apparent to support the latter hypothesis.

The normal range of population fluctuations, capacity for increase and limiting factors of the pine looper require investigation. Meanwhile, the survey has proved of immediate value in indicating areas where control measures are necessary.

Prof. G. C. Varley, of the Hope Department of Entomology, University of Oxford, discussed long-term studies, started in 1949, of the winter moth and other species the larvæ of which defoliate oak trees. This research is currently supported by a grant from the Nature Conservancy. In order to assess the effects of climatic factors and of predators and parasites it is necessary to estimate the population densities of the species concerned as frequently as possible and to understand the life-cycles of the commoner parasites and predators. Some forest insects, like the winter moth, are particularly easy to study: they spend the early summer in the larval stage feeding upon the young leaves of oak, where they can be sampled. From these samples some idea of the effects of parasites and predators can be gained. They then spin to the ground on a silken thread and can be intercepted by traps covering a known area. A detailed investigation of this sample provides an estimate of the factors killing full-grown larvæ.

A census is made of the winter moth adults by trapping a sample as they ascend the trees in November or December. The results can be expressed in the form of a table showing the successive causes of mortality and their percentage. The largest percentage destruction takes place between the time of adult emergence and the appearance of the well-grown caterpillars. The percentage of survival of the eggs presumed to be laid on the trees has been found to vary considerably from tree to tree. On trees which open their buds early some 10 per cent of the expected number of caterpillars can be discovered; but on trees which flush late only 2 per cent of the expectation is found. This is partially due to the dispersal of caterpillars when they first enter oak buds. In windy weather they are blown considerable distances on threads of gossamer and can be trapped at a high

level between the tree tops on sticky traps. The inability of the winter moth to establish itself in trees which open late suggests that it may be possible to choose strains of oak which may be genetically resistant to this form of damage.

Curiously enough, under those trees which open their buds early the heavy caterpillar population suffers proportionately greater destruction when it enters the pupal stage. This may be due to differential attack by predatory animals such as shrews or small rodents in the soil.

At first sight, parasites seem to be relatively unimportant: they kill some 30 per cent at most of the caterpillars of the winter moth. Similar investigations of other caterpillar species have shown approximately the same degree of parasitism. This might be interpreted as an indication that parasites have little effect on caterpillar numbers. However, since many parasites are specific, this explanation would appear to be incorrect. If a specific parasite of an uncommon host is to maintain its numbers it must be extremely efficient at searching for the favoured host. This suggests that the relatively high efficiency of specific parasites may be the basic factor which keeps their hosts to the status of uncommon species, whereas the winter moth and green tortrix, attacked as they are by far less efficient parasites, remain regular pests of great economic importance.

In discussion, Mr. M. V. Laurie, of the Forestry Commission, pointed out that the pine looper has avoided Corsican pine at Cannock Chase. Dr. E. W. Jones, of Oxford, remarked that wood pigeons and squirrels are sometimes the major destroyers of acorns. He also described preferential feeding by mice on acorns from three trees. Analysis showed that the acorns from the preferred tree had the highest sugar and lowest tannin content. Dr. K. R. S. Morris, of the Nature Conservancy, suggested that destruction of carnivores may be largely to blame for upsetting Nature's balance and emphasized that many animals serve a dual purpose: for example, mice distribute seed as well as destroy it.

The chairman, in summing up, said that the papers read had shown that it is the healthy balance in the body corporate which is the fundamental problem.

G. H. THOMPSON

FACTORS CONTROLLING BIOLOGICAL MULTIPLICATION

ON September 24 and 25, the Institute of Biology, with the idea that different fields of investigation often gain from a joint discussion of their results and problems, arranged a symposium on "The Numbers of Man and Animals". The symposium was opened by Sir Alexander Carr-Saunders and he stressed the need for caution in applying the results in one field to the problems of another. There was much vigorous discussion between people of dissimilar training; it demonstrated that the warning had been unnecessary or that it had been heeded. Discussion was greatly helped by the circulation of the papers before the meeting. Most authors assumed, and the assumption seemed to be justified, that their papers had been read; they therefore introduced them with only a brief résumé of the main conclusions and then waited for the argument.

Economics and mathematics dominated the first session. Mr. A. T. Peacock discussed "Economic Theory and the Concept of an Optimum Population". He doubted whether we could predict accurately enough the consequences of changing the size of a population for it to be wise to take any active steps to promote such a change; he therefore thought the proposals to diminish Britain's population from 50 to 25 million were misguided. He also doubted the value of the concept of an optimum population, but not sufficiently emphatically to satisfy Mr. F. Le Gros Clark, who felt that people who are considering the effects of different sizes of market on production often overlook the fact that much of what is produced could be dispensed with without detriment, and perhaps even with advantage, to the community. Several speakers in the discussion pointed out that even if the concept had reality, the ideal size must depend on whether we are trying to arrange for comfort in peace or safety in war, and that many economic arguments are trimmed to suit the supposed requirements of strategy. The uncertainty of forecasts about human populations was the theme of Prof. E. Grebenik's paper; he said that forecasts are at least consistent in one thing—they all prove wrong. The main reason for this, he said, is the incursion of new factors such as sanitation and contraception, which affect numbers in opposite but not always equal ways. Contraception was the main theme of the discussion, and the readiness with which the governments and women of Japan and India accepted it was contrasted with the official obstruction of the Catholic hierarchy and the Communist Party. The attitude of the latter was epitomized by a quotation from the recent United Nations population congress in Rome: "The government of the U.S.S.R. does not believe in fitting population to resources but in fitting resources to population". The widely different attitude of people in different parts of the world was also shown by Prof. I. Schapera in a paper on the position in the Bechuanaland Protectorate which was presented but not discussed because of the absence of the author. The Kgatla hold that it is unjust and ridiculous that a woman should not have a child as often as is compatible with the welfare of any existing children, and the Protestant ethic, which is officially held by many of them, has undergone some consequent modification. Sir Charles Darwin looked on contraception as a palliative, and did not think that either it or the awareness of the danger would keep world population from pressing alarmingly on world resources.

Mr. J. G. Skellam's paper on "The Mathematical Approach to Population Dynamics" provoked a discussion on the relative merits of mathematics and observation, although the author had said that they work best when working hand-in-hand and that modern computing machinery can cope with problems approaching the complexity of actual experimental, even if not natural, conditions. He argued that many ecological experiments are foredoomed to failure by the predictable chance of random extinction because the colonies are so small. Mr. M. E. Solomon pointed out that the rigid mathematical formulation of a hypothesis has the merit that it forces attention on to the component parts of the hypothesis and so might reveal methods of testing not apparent from a verbal statement.

In the next session, Dr. D. Lack gave examples of the types of factor that control the density reached by different species of animal, and he showed that generalization from one species to another is hazardous. In wild populations, reproductive rate is

mainly controlled by food shortage, predation, and disease. These factors interact and the position is still further complicated by the effect, on predation of one species, of variations in the numbers of an entirely different alternative food species. Dr. D. H. Chitty brought out a different aspect of the problem by describing striking physiological differences, which are apparently transmitted to the young, between voles maintained under different conditions of crowding and intraspecific strife. It has for long been apparent that neither food shortage nor disease gives an adequate explanation of the periodic 'crashes' in the numbers of wild voles. The new factor is that voles in stable and in rapidly expanding communities differ in rate of growth and in the weights of such organs as spleen, adrenal and testis; there is therefore no need for us to be surprised if their reproduction- and survival-rates are widely different too. Prof. T. Park described his extremely comprehensive experiments on interspecific competition using two similar species of flour beetle, *Tribolium confusum* and *T. castaneum*. From them it appeared that the successful species need not be the one that in isolation would have reached the greatest density, that the change which ultimately would lead to the extinction of one species probably took place early in the association, and that the permanent co-existence of two species which compete is improbable. One environment, flour, was used and six climates in which the temperature varied from 24° to 34° and the humidity from 30 to 70 per cent; these affected the species differently, so that sometimes one and sometimes the other prevailed.

Although Park had said, "Most probably, if causation were better understood for control cultures, the usual, and unusual, events seen in experimentals could be more accurately forecast", much of the discussion turned on the extent to which the concept of a random event, for example, the random extinction of a species, has any value. If events are random in a fully controlled environment, then, as one speaker put it, "the beetles were just being used to work out sums"; if not, the important feature is to ascertain the precise nature of the competition and the mechanism by which one species eliminates the other. Several speakers mentioned other species in which crowding affects physiology; for example, *Eurygaster* was quoted by Prof. J. B. Cragg as living on wheat for as long as its numbers are increasing but on other plants during the phase of decline.

In the third session, the symposium started with man before moving on to his domestic animals. Prof. A. L. Banks surveyed the history of disease control in Britain and other countries and, taking *festina lente* as his motto, urged the need for caution before upsetting the established customs of other countries by the immediate introduction of our public health measures. His plea that "No matter what new discoveries are made in the future, whether they include a 'cure-all' for disease, or a simple method of preventing conception, action on a large scale should be withheld until all the implications have been fully thought out", demands perhaps too much *lente* when we consider that the consequences of a single change in a laboratory colony of *Tribolium* have not yet been fully thought out. There was, however, general agreement with his strictures on the Olympian use of the word 'we'. The motives that lead people to decide that 'we' will do something for or to a less developed community have in the past been fear, altruism and economic needs. These motives are still with us; they vary in acceptability; but, whatever the motive, there is little chance of a successful and stable result unless local opinion understands the activity and co-operates in it.

From the chair, Prof. J. Z. Young urged speakers not to be apocalyptic, but to remember that at each stage of history thoughtful people had maintained that the world was in a very unpromising condition. Dr. F. Fraser Darling thought they had probably been right, and commended a Brahman who released trapped rats during a plague epidemic; but most contributors to the discussion had a more optimistic outlook. Mr. Le Gros Clark stressed that a community that has been freed from the most debilitating diseases, even if it does in consequence have occasional famines, will, for physical reasons, recover from them better than one that is still debilitated; and also, as Dr. C. Gordon put it, "because they are people who are aware of having been well". For each reason, in the fit of anger that is likely to succeed the famine, they are more likely to do something about the causes that led to it.

Dr. A. S. Parkes dealt vividly with the research that is being done on contraception, on the factors that affect the sex ratio in man and animals, and on the preservation of sperm by freezing. Present-day contraceptive methods are inefficient anachronisms, and he surveyed the various possible modes of approach, stressing the advantages of finding something that would, when eaten, inhibit spermagenesis or ovulation. He was, however, unconvinced that any of the plant extracts used by primitive peoples have a significant contraceptive effect. Work on the third problem may be of great short-term importance in solving the first, because the successful preservation of human sperm goes far to offset the irreversibility that has hitherto been the primary objection to vasectomy as a mode of contraception.

Dr. P. S. Henshaw, Sir Charles Darwin and Mr. E. M. Nicholson stressed the point that, whether a community wishes larger or smaller numbers, the wish cannot become effective until we know more about the processes of fertilization and implantation. They contrasted the importance of this work with the niggard support coming from public funds. In suitable circumstances, venery and fecundity are each commendable, but they are separate human activities and the breaking of their historically necessary association is long overdue.

Human communities with a high standard of living tend to have low birth-rates, whereas the opposite is true of domestic animals. The reasons for this apparent contradiction were considered by Dr. J. Hammond and others. No definite conclusion was reached in the discussion, but it appeared that the effect in animals is physiological whereas in man it is the consequence of associated social and cultural changes; where improved nutrition does not lead to these changes, it increases human fertility also.

In the final session, Fraser Darling presented a spirited analysis of the ravages man has wrought in most of the areas he has dominated, though he accepted pastoralism as less harmful than other activities so long as it is fully nomadic. In discussion he extended the area best suited to pastoralism to include 'wet deserts' such as Scotland, but did not carry the audience fully with him; several speakers thought that if a little intelligence were used it should be possible to restore fertility to land without letting it revert to scrub for intermittent twenty-year periods. Prof. L. S. Penrose made the basic assump-

tion that an inhomogeneous population probably finds its variety useful, and described various ways in which what at first sign seem to be harmful traits can be of use in a community. He was unconvinced that civilized communities are deteriorating in the manner that eugenists commonly assume, and he argued that, even if there were this deterioration, there is no reason for thinking that it has a genetic rather than an environmental origin. Colourful phrases such as 'humanity is silently rotting at the core' and is being 'recruited from submen' seemed to him without foundation and no one in the audience saw fit to support them. The topical question was raised of the long-term genetical effects of the increase in radiation to which, as a result of industry and nuclear weapon testing, we are being exposed. Penrose thought that the increased mutation-rate that this would probably lead to, simply added one more imponderable to an already ample supply, and would make no positive predictions about its effect.

Lord Boyd Orr, summing up the symposium, said that he welcomed all the developments there might be in sanitation and preventive medicine, on one hand, and contraception on the other. To a large extent they cancel one another out, but he expected the world to hold perhaps 4G (G = 10^9) people by 1980 and 5 or 6G by the end of the century. This prospect, and the prospect that the existing ratios between the numbers of the different nationalities would be altered, left him unworried. With modern knowledge, food production could be increased by a larger factor than population is likely to increase by, and there could be enough for all. The difficulties that he foresaw were political rather than scientific. Physics appears to governments to be much more useful than biology both in war and for making money; it therefore gets the lion's share of research endowment. People had got on very well in the past without jet planes and hydrogen bombs, but they could not get on without food, and he looked forward to an era of agrarian abundance in which we no longer galloped through irreplaceable resources with our present abandon but farmed wisely and depended for our energy supplies primarily on the inexhaustible flow from the sun. He looked forward to a magnificent new world even though it is likely to be very different from the one we have known as children. But we would only get it if we got rid of fear and used our wits.

The humanism of Lord Boyd Orr's tone of exuberant confidence suited the mood of the symposium and it finished in an atmosphere of restrained optimism. It did not, however, go so far as to produce overt Swinburnian exaltation: "Glory to Man in the highest! for Man is the master of things".

N. W. Pirie

CHEMICAL RESEARCH LABORATORY, TEDDINGTON

OPEN DAYS

FOR the eighth year in succession the Chemical Research Laboratory, Teddington, was open to visitors from universities, industry and government departments during September 28–October 1. Exhibits by the High Polymers Group illustrated how systematic changes in the structure of the resin matrix and the number or nature of the functional groups can lead to resins of particular value in specific separations. Resins containing amphoteric groups were shown which act as insoluble sequestering agents with great selectivity for certain ions such as copper. Of special interest were the ion-selective membranes. These are of considerable importance in physical and biological science and are being used in osmometry and dialysis. Polyvinyl alcohol and methoxymethyl nylon films of graded permeability have considerably extended the scope and accuracy of osmotic pressure measurements; other membranes show promise for use in the dialysis of aqueous solutions.

The Radiochemical Group showed a wide range of chromatographic methods of analysis as applied to the inorganic field. A striking example was the simplified and rapid method for field use in geochemical prospecting. Applications of ion-exchange resins were demonstrated: in one, the quantitative separation of metals such as copper, cobalt and nickel adsorbed on an acidic ion-exchanger was effected by an organic solvent; in another, gold and other metals (such as zinc, nickel, copper, iron, silver and cobalt) adsorbed on a strong base exchanger could be eluted separately by use of suitable organic solvents. Other separations involved the use of ion-exchange membranes.

A novel apparatus for continuous extraction of a metal salt solution by organic liquids consisted of a rotating cylinder mounted concentrically inside a stationary outer vessel; the liquids passed countercurrent in the annular space between the cylinders. The measurement of carbon-14 based on the use of acetylene in a scintillation counter was demonstrated, the acetylene being prepared from carbon dioxide by reaction with lithium and conversion to carbide. The method is particularly useful for very low activities.

In the Inorganic Group, an exhibit demonstrating the occurrence of selenium in wastes from the flash-roasting of pyrites typified the interest taken by the Laboratory in waste materials as sources of valuable products. Wastes from pyrites plants arise in the final purification of the sulphur dioxide by acid wash or water sprays; samples were shown containing from 20 to 60 per cent of selenium. Methods of recovering the element are being studied and various products were on view, as well as excellent specimens of the various allotropic modifications of selenium. Work has been commenced on the separation of rare earths by ion-exchangers, and promising separations of the cerium group of elements have been made using ethylenediamine tetra-acetic acid as the eluting agent. Techniques for the preparation of pure rare-earth metals are being studied, and samples of cerium and lanthanum by reduction of the fluorides with lithium were shown. The fine collection of metals of high-degree purity held by the Laboratory on behalf of the Pure Metals Committee of the Department of Scientific and Industrial Research was again on view.

The current programme of the Organic Group was illustrated by collections of new intermediates and pure chemicals of potential usefulness. A recently introduced technique, that of zone melting, was shown in its application to the purification of organic compounds. The convenience of this method lies in the ease with which the cycle of operations can be repeated automatically. The purification effected was strikingly demonstrated by the removal of a coloured material, induline, from naphthalene.

Other interesting apparatus included that used for pressing clear disks from mixtures of pure potassium chloride and various solid organic materials for

examination by infra-red absorption spectroscopy; a cryoscope for measurements of the vapour pressure of acetylene; and a micro-analytical train in which isotopically labelled carbon dioxide was collected for isotope abundance measurement. Progress in preparative and synthetic work was shown under the following headings: an exploration of possible uses of 4-hydroxy-*iso*phthalic acid and its derivatives; reactions of epoxides with phosgene; isomerization of ethyl*cyclo*pentane; new methods of labelling aromatic compounds; and new ion-exchange resins.

The National Collection of Industrial Bacteria presented a colourful exhibit in which various pigment-producing bacteria were used to produce paintings and the printing of words on agar plates. The more prosaic work of the Collection was illustrated by demonstrations of the techniques employed in identifying, classifying and preserving bacteria.

An apparatus of interest to fermentation technologists was that used for the continuous anaerobic culture of sulphate-reducing bacteria, in which hydrogen is the reducing agent and carbon dioxide the main carbon source. The apparatus, which was developed at the Microbiological Research Department, Porton, for aerobic organisms, can be adapted for the culture of most micro-organisms; the continuous technique is claimed to be more efficient than batch fermentation. A process for the production of sulphide from sulphated sewage sludge was demonstrated. At present the sulphide is produced at the expense of the valuable methane formed during the normal digestion of sludge; attempts are being made to enable the two processes to proceed simultaneously. Chromatographic techniques have been applied to follow the carbon metabolism in sulphate-reducing bacteria, and a new type of cytochrome has been detected in these organisms. This is the first time that a cytochrome has been observed in an anaerobic organism.

The field covered by the Corrosion Group was strikingly demonstrated by a wide variety of exhibits. Of particular interest was a collection of characteristic examples of damage by corrosion in industry and in the home. The common danger of using unsuitable combination of metals in constructions was illustrated by galvanic cells in which various pairs of metals were immersed in salt solution. Specimen tubes and histograms of corrosion data showing the influence of various treatments of tubes and boiler water illustrated the study of the corrosion of mild steel tubes in Scotch marine boilers undertaken on behalf of the British Shipbuilding Research Association. New studies of the oxidation of special steels in flue-gas atmospheres have been commenced in collaboration with the British Electrical and Allied Industries Research Association and the British Iron and Steel Research Association; a new apparatus designed for this work was on view.

Ancient buried iron objects in a good state of preservation illustrated the inhibitive effect of tannins in the soil on the activities of sulphate-reducing bacteria. Field trials of tannins as a means of combating underground corrosion are in progress. Recent work on the prevention of tarnishing of copper and silver has led to the use of paper wraps impregnated with certain compounds, for example, copper chromate. The method is based on the removal of traces of hydrogen sulphide from the air. Other exhibits included the rapid attack of steel by aqueous suspensions of sulphur; the use of *cyclo*hexylamine carbonate as a vapour-phase inhibitor; applications of sodium benzoate and sodium nitrite in cooling systems; and examples of filiform corrosion. A new and comprehensive classification scheme for corrosion topics was on view.

NEWS and VIEWS

Nobel Prize for Physiology and Medicine: Profs. J. F. Enders, F. C. Robbins and T. H. Weller

The Nobel Prize for Physiology and Medicine for 1954 has been awarded jointly to Prof. John F. Enders, of Boston, Prof. Frederick C. Robbins, of Cleveland, and Prof. Thomas H. Weller, of Boston, for their work on poliomyelitis. This team of workers had been studying the growth of certain human viral infections in tissue culture. Early in 1949, they announced that the Lansing strain of poliomyelitis virus caused cytopathogenic changes in cultures of various human embryonic tissues and that this action could be neutralized by specific antibody. Afterwards, their isolation of the three known serological types of poliomyelitis virus in tissue cultures by direct inoculation with fæcal material from human subjects, along with the demonstration of direct typing of the virus strain with specific antisera, has opened up a new field in the laboratory diagnosis of the disease and is providing also a valuable technique for epidemiological studies. The utilization of tissue-culture methods for the possible production of safe poliomyelitis vaccines is another immediate result of immense practical importance and is now being actively pursued.

An additional contribution of all this work is that it has brought poliomyelitis research within the reach of investigators previously debarred by lack of elaborate experimental facilities. Of special importance, however, to virus research is the unequivocal demonstration that an apparently strictly neurotropic virus can multiply *in vitro* in cells which are not ordinarily susceptible to it *in vivo*, and the conditions and mode of growth in such a system have applications for other problems. Within the past year, Prof. Weller has described the cultivation of chicken pox and herpes zoster viruses, and Prof. Enders that of measles virus in tissue culture. The stimulus of all these discoveries is activating research not only in virology but also in microbiology generally.

Presidency of the Royal Aeronautical Society: Mr. N. E. Rowe, C.B.E.

Mr. N. E. Rowe, technical director of Blackburn and General Aircraft, Ltd., Brough, East Yorks, has been selected as president-elect of the Royal Aeronautical Society and will take office at the annual general meeting of the Society to be held on May 5, 1955. After his apprenticeship in marine engineering at Devonport Dockyard and service in the First World War, Mr. Rowe went to the Imperial College of Science and Technology, London, holding a Royal scholarship and Whitworth exhibition, and gained a diploma of the College in 1924 for postgraduate

work in hydro-electric engineering. During 1924–46 he was employed by the Air Ministry and the Ministry of Aircraft Production, becoming director of technical development in 1941 and director-general of technical development four years later. From 1946 until the end of 1951, when he took up his present post, Mr. Rowe was controller of research and special developments for British European Airways. He was elected a Fellow of the Royal Aeronautical Society in 1942, and has been a member of council since that year; he is also a member of council of the Helicopter Association. In 1944 he was made C.B.E. for his work in the Ministry of Aircraft Production.

Chemical Engineering in Great Britain

In his presidential address on April 30 to the Institution of Chemical Engineers at the thirty-second annual meeting, Mr. Stanley Robson spoke mainly on the progress of the Institution and the steps it is taking to assist industry by the provision of highly qualified chemical engineers. The full address, which has only recently been made available, includes many interesting figures, among which may be specially mentioned the increase in production of the chemical industry by 29 per cent from 1948 to 1952. In the same period the number of operatives scarcely changed, indicating the greatly improved efficiency per man employed. This is no doubt largely due to the increase of 20 per cent in the number of qualified scientific workers in the industry. Membership of the Institution simultaneously increased by the satisfactory figure of 30 per cent, while training facilities, in which it is keenly interested, are now available in more than twenty colleges as opposed to four in 1934. Comparative tables showing the relative numbers of chemical engineers employed by different industries in Great Britain and in the United States, and also the numbers engaged in various occupations such as plant operation, show, generally speaking, remarkable agreement, the main differences being that 20 per cent held administrative posts in Britain, as opposed to 10 per cent in the United States, and 22 per cent undertook research and development, as against 31 per cent. It follows that statements which have been made that chemical engineers in the two countries have different functions, and that consequently their training should be on different lines, have little to support them. A more important problem is the securing of adequate supplies of men to train, and the Institution, by issuing the publication "Careers in Chemical Engineering", for which there has been a widespread demand, has made a very valuable contribution to this side of the question. As Mr. Robson pointed out, in spite of this and the many other activities of the Institution for encouraging the development of chemical engineering and keeping its members in touch with recent progress, there is no room for complacency. The present trend in the chemical industry is to build much larger and more complicated units of plant; this can only be done after extensive and costly research and by making use of chemical engineers of the first grade, with scientific training of the highest order.

Bulletin of Endemic Diseases

Important developments in preventive medicine in Iraq have prompted the publication, by the Institute of Endemic Diseases, Baghdad, of a new journal, the *Bulletin of Endemic Diseases*, the first issue of which is dated July 1954 (6*s*. per issue; 20*s*. for four issues). The *Bulletin* will be issued approximately every six months and its articles will be in English. Issued with the authority of the Ministry of Health and the Government of Iraq, this new journal is tastefully produced and well printed in Baghdad. Its objects are to publish original papers on the epidemiology of parasitic and insect-borne diseases, especially those relating to Iraq. This first issue contains a detailed summary, by Dr. Gordon Pringle, of the Institute of Endemic Diseases, Baghdad, of existing knowledge of malaria in Iraq before 1946 and of its control; an article, by the same author, on the identification of adult anopheline mosquitoes of Iraq and neighbouring territories; a preliminary study, by Hannah Zakaria, of the Biology Department, Royal College of Medicine, Baghdad, of the bionomics of snails belonging to the genus *Bulinus* in a locality near Baghdad, the inhabitants of which are heavily infected with schistosomiasis; a preliminary report, by Younis Bashir, of the Pathological Laboratory, Royal Hospital, Mosul, on the occurrence of infantile kala-azar in northern Iraq, with an editorial comment on other cases observed in the region of Baghdad and central Iraq and on the survey of sand-flies (Phlebotominae) of infected localities that has been begun; and an account, by Haikal Riyadh and Mohammed Azzawi, of the Institute of Endemic Diseases, Baghdad, of a comparison of the efficiency of two types of sprayer used for malaria control with DDT. Everyone interested in the progress of knowledge of tropical medicine will welcome this addition to the literature of this subject and will wish every success to its editorial board and to the workers whose results will appear in this new *Bulletin*. The Institute of Endemic Diseases is establishing a library, and its secretary appeals for exchanges of journals on tropical medicine and hygiene, medical zoology and parasitology, microbiology, hydrobiology and related sciences.

Histochemische Methoden

A useful new publication entitled *Histochemische Methoden* has appeared under the editorship of Dr. Walter Lipp, of Graz, Austria. It consists of concise working directions for carrying out the selective staining of tissues for the detection and location of specific inorganic and organic substances, chemical groupings and enzymes. General histochemical procedures such as preparation of tissues will also be covered. A short bibliography is provided with each method. The three issues which so far have appeared have included among other topics the detection of potassium, arginine, carbohydrates (polysaccharides), sulphydryl and disulphide groups, and esterases. The publisher is R. Oldenbourg, of Munich, and the price is 30 DM. a year (six parts) or 6 DM. for separate parts.

Forest Products Research: Report for 1953

The report for 1953 of the Forest Products Research Board, together with the report of the Director of Forest Products Research (pp. vi+62+8 plates. London: H.M. Stationery Office, 1954. 3*s*. net), opens with the statement that the major work of the year has continued to be the evaluation of new tropical species of likely importance, while there has been an increasing amount of testing and assessment of sample consignments of home-grown species from the plantations of the Forestry Commission. The former work is undertaken with the object of finding new timbers from the tropical forest likely to be of

importance to manufacturers and timber users. This latter research is of first-class importance to the tropical sylviculturist, for such knowledge will assist him in the future management of tropical crops in which formerly only one or two species had any marketable timber value. Kiln-drying experiments are still being undertaken, especially in connexion with the hardwoods, where favourable results are being obtained. Satisfactory factors are coming to light in connexion with wood bonding and the weathering of plywood investigations. In this latter, weathering tests have been carried out both in Britain and in Nigeria over the past three years. The principal object of the tests was to assess the durability of the glues used in the manufacture of plywood. In the entomology branch, studies of the common furniture beetle and the house longicorn beetle, the latter a serious pest on the Continent of Europe but in Great Britain chiefly confined to Surrey, have been given priority because of their importance.

Similarity of Algal Proteins

The gross chemical composition of many algae has now been recorded. In a recent paper, W. Fowden (*Ann. Bot.*, N.S., **18**, 71, 258; 1954) describes how he has isolated representative protein fractions from species from four different systematic classes, namely, *Chlorella*, *Anabaena*, *Navicula* and *Tribonema*, and made quantitative determinations of their amino-acid compositions. This important investigation has shown that there is a close similarity in the proteins of the four species selected for study, and hence the tentative conclusion is reached that the protein complements of all algae are similar. It will be recalled that the contemporary accepted classification of the algae is based on the composition of their pigments and storage materials. The author points out that his analytical methods only provide an average amino-acid composition of the bulk protein of each species and can give no information regarding the nature and reaction of the individual proteins which may be present. He has also indicated that there is a general similarity between the bulk proteins of algae and those of the leaves and tubers of some flowering plants and of *Nitrosomonas*; but, as with the algae, these materials probably contain different individual proteins, these determining the characteristic metabolism of the species.

Root Culture and Biochemical Genetics

The technique of excised root culture affords a means of investigating the hormonal control of plant growth and seems likely also to prove of value in biochemical–genetical studies of the tissues of higher plants. W. G. Boll (*New Phytol.*, **53**, 2, 177; 1954) has discussed the problems involved in the application of the technique of root culture to comparisons between strains and hybrids of the tomato. The growth of six clones of excised roots, each derived from a different seed of one inbred plant of an inbred line of tomato, was studied through a series of passages. Both quantitative and qualitative differences were found between the clones. The implications of the results are discussed. Using a seven-day passage and a modified White's medium it was found that root apices, of the strains and hybrids of tomato used, only occasionally survived on subculture into a second passage. Experiments designed to overcome this difficulty are described. Reduction of the passage length, or control of *p*H drift, increased the expectation of life of the apices on subculture; but conditions permitting continuous subculture of the radical apex were not realized. The implications of these results, and of the effects of the different media on the growth of excised tomato roots, are discussed.

University of Birmingham

Dr. C. A. Rogers, formerly reader in the Department of Pure Mathematics, University College, London, has been appointed to the Mason chair of pure mathematics in the University of Birmingham. The following appointments have been announced by the University: Dr. J. D. Lawson, lecturer in geology; Dr. J. N. Pratt, lecturer in physical metallurgy; M. G. Cockcroft, lecturer in industrial metallurgy; F. Benson, lecturer in engineering production; Dr. A. Kelly, Imperial Chemical Industries, Ltd., Fellow in industrial metallurgy. Dr. S. R. Carter, lecturer in chemistry in the University, has recently retired. The following have resigned their posts: Dr. C. S. Ball, lecturer in industrial metallurgy; Dr. J. H. Cort, lecturer in physiology; Mrs. B. Eckstein, lecturer in geography; H. Grisbrook, lecturer in engineering production; Dr. H. Nuttall, lecturer in mechanical engineering; E. C. Park, research Fellow in physics; Dr. C. A. Ramm, lecturer in physics; G. K. Williamson, Imperial Chemical Industries, Ltd., research Fellow in physics; J. Y. Freeman, Department of Scientific and Industrial Research research assistant in physics; R. F. Coe, Department of Scientific and Industrial Research research Fellow in physics.

Bishop Museum, Honolulu, Hawaii

The annual report of the Bishop Museum for 1953 recalls that the Bernice P. Bishop Museum was founded in 1889 with a sphere of interest described as "Polynesian and kindred antiquities, ethnography and natural history". The Museum made its reputation through its sponsorship of field research in the natural history and anthropology of the Pacific area and through publication of the results of such research. But those concerned with the Museum realized that their educational rôle lay in the diffusion of knowledge. Although the Bishop Museum had maintained exhibition halls, it had no policy in this direction, and one of the present major objectives is to transform the Museum into an effective instrument of education through informative and dramatic display techniques in the galleries.

University of Sheffield

The following appointments have been made in the University of Sheffield: Dr. A. Roberts, senior lecturer in the Postgraduate School of Mining; P. B. N. Neal and D. M. Woo, lecturers in mechanical engineering; and P. H. Mann, lecturer in social studies. The following have resigned their posts in the University: Dr. H. E. Harding, reader in pathology, on appointment as director of pathology to the Salisbury Area Pathological Service; Dr. R. Shepherd, senior lecturer in the Postgraduate School of Mining, on appointment as a senior scientist with the National Coal Board; Dr. C. E. Davies, senior lecturer in medicine, on appointment as consultant physician to the United Sheffield Hospitals; B. R. Dudley, lecturer in applied mathematics; Miss C. M. Hamill, lecturer in pure mathematics; and F. G. West-Oram, lecturer in glass technology. Mr. P. Irwin Packington has given a cabin cruiser to the Department of Zoology for use in both coastal and inland waters.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: J. Bowden (entomologist, Gold Coast), senior specialist, Department of Agriculture, Gold Coast; T. W. Brandon (government chemist, Public Works Department, Gold Coast), specialist, water examination, Public Works Department, Gold Coast; N. O. Walsh (senior scientific officer, Jamaica), deputy government chemist, Jamaica; H. M. Maugham-Brown (assistant conservator of forests, Tanganyika), conservator of forests, Tanganyika; T. P. Lecky (senior livestock officer, Jamaica), chief livestock officer, Jamaica; C. S. Ramage (scientific officer, Royal Observatory, Hong Kong), assistant director, Royal Observatory, Hong Kong; R. H. Bennison and B. F. Hanger, agricultural officers, Kenya; B. Buckler, agricultural officer, Zanzibar; D. L. Curtis, plant breeder, Nigeria; J. W. Deering, agricultural officer, Fiji; G. Dowson, agricultural officer, Sarawak; M. J. Furber and A. B. Hearn, agricultural officers, Nyasaland; R. C. Knill, agricultural officer, Sierra Leone; W. P. Mowat, plant pathologist, Tanganyika; A. J. Pritchard, botanist, Uganda; J. J. Rae, agricultural officer, Nigeria; E. M. Laing, field geologist, Sierra Leone; G. P. Jones, geologist, Nigeria; A. R. Newton, geologist, Northern Rhodesia; W. J. Phillips, geologist, Uganda; R. D. Brown, veterinary research officer (virologist), East Africa High Commission; T. E. Fletcher, scientific officer (chemist), East African Malaria Unit; M. C. Williams, medical research officer, grade 3, East Africa High Commission; J. Williamson, research parasitologist, West African Institute for Trypanosomiasis Research, Nigeria; J. R. Lang-Brown, assistant conservator of forests, Uganda; M. J. Davies, assistant conservator of forests, Nigeria; S. R. M. Harvey, geologist, Fiji; Miss E. M. Holden, biochemist, West African Cacao Research Institute, Gold Coast; J. E. McKerlie, assistant conservator of forests, Tanganyika; E. B. May, agronomist, West African Institute for Oil Palm Research, Nigeria; J. C. Parkinson, assistant conservator of forests, Fiji.

The Night Sky in November

FULL moon occurs on Nov. 10d. 14h. 29m., U.T., and new moon on Nov. 25d. 12h. 30m. The following conjunctions with the moon take place: Nov. 3d. 19h., Mars 5° S.; Nov. 15d. 14h., Jupiter 2° N.; Nov. 24d. 03h., Saturn 6° N.; Nov. 24d. 03h., Mercury 6° N.; Nov. 24d. 07h., Venus 2° N. In addition to these conjunctions with the moon, Mercury is in conjunction with Saturn on Nov. 24d. 01h., Mercury 0·4° S., and also in conjunction with Venus on Nov. 25d. 05h., Mercury 3° N.; and Venus is in conjunction with Saturn on Nov. 29d. 00h., Venus 2·5° S. Mercury is a morning star and rises nearly two hours before the sun on November 15, when it is visible, but throughout most of the month it is too close to the sun for observation. Venus is unfavourably placed for observation during most of the month and is in inferior conjunction on November 15. At the end of the month it rises about two hours before the sun and can be seen in the eastern sky, stellar magnitude −4. Mars, an evening star, sets at about 22h. 10m. during the month. Its stellar magnitude varies between 0·1 and 0·5, the decrease in brightness being due to its increasing distance from the earth—from 91 to 111 million miles. It moves from Capricornus into Aquarius, and on November 10 it lies almost south of and close to θ Capricorni. Jupiter rises at 21h. 35m., 20h. 45m. and 19h. 40m. on November 1, 15 and 30, respectively; owing to its decrease in distance from the earth by about 38 million miles, its stellar magnitude changes from −1·8 to −2 during the month. Saturn, in conjunction with the sun on November 5, is unobservable in the early part of the month; on November 15 it rises less than an hour before the sun but by the end of the month it rises at 5h. 30m., more than two hours before sunrise, and can be seen a little north-east of α Librae. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Nov. 5d. 23h. 55·7m., κ Aquar. (*D*); Nov. 6d. 22h. 27·7m., κ Pisc. (*D*); Nov. 12d. 23h. 38·6m., 121 Taur. (*R*); Nov. 14d. 05h. 52·3m., *d* Gemi. (*R*); Nov. 20d. 03h. 45·9m., 13*B* Virg. (*R*). (*D*) and (*R*) refer to disappearance and reappearance, respectively. The Andromedid meteors, associated with Biela's Comet, attain their maximum about November 28.

Announcements

DR. D. A. ALLAN, director of the Royal Scottish Museum, Edinburgh, has been elected president of the Royal Scottish Geographical Society.

THE title of reader in computational methods in the University of London has been conferred on Dr. A. D. Booth, in respect of his post at Birkbeck College.

As part of the United States conditional aid programme, the Ministry of Agriculture of Northern Ireland has awarded three postgraduate scholarships, each £600 a year, for a period up to two years, as follows: two scholarships in agricultural economics (farm management) to G. L. Morrison (University of Reading) and W. Thompson (University of Leeds); one scholarship in agricultural statistics to A. A. Rutherford (University of Aberdeen).

THE Fulmer Research Institute, Stoke Poges, Bucks, is arranging an open day, which will be held on November 2.

THE work of the London Group Laboratories of the British Iron and Steel Research Association will be open for inspection at 140 Battersea Park Road, London, S.W.11, on November 18 and 19.

IN conjunction with the annual congress of the British Institute of Radiology, an exhibition of X-ray apparatus will be held at the Royal Horticultural Hall, Vincent Square, Westminster, London, S.W.1, during November 23–26 (Nov. 23, 2 p.m.–6 p.m.; Nov. 24 and 26, 9 a.m.–6 p.m.; Nov. 25, 9 a.m.–8 p.m.). Admission tickets, which are free, can be obtained from the British Institute of Radiology, 32 Welbeck Street, London, W.1.

THE Northern Branch of Aslib will hold a one-day conference on November 19 in the North of England Mining and Mechanical Institute, Neville Hall, Newcastle upon Tyne, with Mr. R. W. Mann, managing director of Victor Products, Ltd., Wallsend upon Tyne, in the chair. Four papers will be read dealing respectively with the activities of Aslib; public technical library service for industry; microfilming; and new ideas and the small firm. The conference will be open to non-members on completion of a registration form (to be returned by November 12) which is obtainable from the honorary organizing secretary, Mr. E. Westerby, 11 Duchess Street, Whitley Bay, Northumberland.

THE MURDOCH BICENTENARY

THIS year marks the bicentenary of the birth of William Murdoch (1754–1839), the originator of gas lighting. For that great achievement alone he would stand out as a great figure in the history of progress, yet it was only one of his many inventions. The story of his life should serve as an incentive and example to every scientific worker. Possibly forgotten is the incident of the wooden hat which brought about his association with Matthew Boulton and James Watt, and his opportunity for achievement. After having walked all the way from his home in Ayrshire to the now famous Soho Works in Birmingham, he might have been turned away by Boulton had not Murdoch dropped his wooden hat at the prospective employer's rebuff. Boulton noticed, however, the unusual character of his headgear, questioned him about it, and learnt that he was the inventor of the oval lathe with which he had made it. That was the beginning of the famous triple partnership.

As a boy, Murdoch had made himself 'a wooden horse' for his journeys to school, a distance of 2½ miles; it was the forerunner of the tricycle and the bicycle, which only became a practical reality many years later. This experience ultimately led him to construct a model non-condensing locomotive steam-engine, now in the Birmingham Art Gallery; but his attempts to patent it were, strangely enough, opposed by Watt. An entrancing story of these early beginnings and his many other remarkable inventions has been recently published in *West's Gas*, the house journal of West's Social Society, from the pen of his great-grand-niece, Margaret L. Murdoch. Attractive, too, is the 1954 Murdoch Memorial Lecture of the Institution of Gas Engineers, under the distinguished authorship of no less a person than the chairman of Imperial Chemical Industries, Ltd., Dr. Alexander Fleck. Therein has been paid a fitting tribute to Murdoch's memory in a very informative account of the origins and development of gas for industrial purposes, viewed from the angle of an organization which has, above all others, so successfully applied the service of gas to the chemical industry. It is, in Dr. Fleck's words, a record "of the development of a great concert of industrial processes—today as powerful and as full of promise as ever before to make available the things we value in our way of living".

In effect, gas becomes increasingly a great source of chemicals. The vast output of ammonia and nitric acid for chemical manufacture and explosives are the products of a synthesis which begins with the gasification of coke, and the production of hydrogen and carbon monoxide, as water gas. The same process is the starting point of that remarkable synthesis of hydrocarbons and the complex series of by-products associated with the Fischer–Tropsch process, so actively applied to the German economy in the Second World War. From the same origins, with benzene, is produced nylon. From the hydrogenolysis of natural oils and fats arise higher alcohols, solvents and plasticizers, to mention but a limited range of many wonders.

To turn to the wider needs of the fuel industries, there must ultimately come an urgent and crying demand for the greater application of total gasification in the gas and heavy industries, for the supplies of good coking coals are showing signs of exhaustion, and processes must be devised to utilize weakly and non-caking coals. The 'smog' problem also points out the same objective. With the provision of cheap gas for industry, the efficiency and adaptability of many types of heating and processing plant become greatly advanced. A process for the cheap production of oxygen would expedite all the prospective developments in this field. That the gasification of oil may also serve as a useful adjunct to the processes based on coal may be envisaged with a measure of certainty. In the pursuit of these objectives, reference to the example of Murdoch's career may be timely—to the example of his energy and persistence in an age when technical skills were weak and groping, under rebuffs and disappointments such as the opposition of no less a person than Watt. But for this opposition, Murdoch's locomotive would have been an accomplished fact nearly half a century before Stephenson's, and a quarter of a century before Trevethick's. Indeed, as a boy, Trevethick had been a frequent visitor to Murdoch's home at Redruth, and must have seen him at work on his engine. It is said that Trevethick purchased the model from the disappointed inventor. Murdoch has been called "the incomparable mechanic"; further, we must recognize what an amazing achievement has emerged from disappointment and effort.

R. J. Sarjant

THE HEALTH OF CHILDREN

A NEW exhibition at the Wellcome Historical Medical Museum, at 28 Portman Square, London, W.1, deals with "The Child Through the Ages" and illustrates by means of skilfully selected objects, books and prints the methods which have been used to feed, clothe and transport the young child from early times. It also shows the development of the idea that disease in the child is often so different from that in the adult as to warrant the creation of the specialty later termed 'pædiatrics'. This exhibition covers the whole field from the earliest times to the beginning of the present century. It contains many objects of great beauty, and is worthy of the traditions of the Wellcome Museum.

It is well known that the Museum possesses a very fine collection of effigies of ancient Egyptian gods, and a few of these are shown in this exhibition. In the classical period of Greece and Rome the emphasis is rather on the portrayal of the mother with her child. Third-dimensional art had become fully representational, and the artists found in this theme a congenial subject. Some of these third-century B.C. terra cottas show a gracefulness of line which often escapes more ambitious compositions. The marble bas-relief from Ostia of a mother suckling her child exhibits a different treatment from that used in the Greek figures, and is also noteworthy.

During the medieval period, the attitude of the Christian Church resulted in the cult of certain saints who were especially concerned with the care of children. This attitude is exemplified by several very interesting Breton effigies in wood, dating from the

thirteenth century and later. The Renaissance saw the foundation of the Ospedale degli Innocenti at Florence, with its well-known Della Robbia medallions, and there are exhibited a number of interesting illustrations of this and similar institutions.

So far as the management and treatment of children were concerned, there was little change in practice from the time of Soranus (first century A.D.) until the seventeenth century. During the sixteenth century the popular emphasis was on swaddling clothes, the bath and the baby's toilet. Prints by the Dutch, French and Italian masters depict such scenes, and sometimes show practices which are not referred to in the books of the period. The humanitarian movement in Great Britain, so well epitomized by Thomas Coram with his establishment of the Foundling Hospital, led finally to George Armstrong's dispensary (1769) and to the foundation of hospitals for sick children. The Industrial Revolution and the consequent employment of children in industry led to results which are illustrated by contemporary documents. The work of the great Victorian sanitary reformers had an important bearing on the welfare of children. But it was towards the close of the nineteenth century that French work on infant feeding was taken up in Britain and led directly to the great infant welfare movement.

The development of pædiatrics as a specialty is well illustrated in this exhibition by the first editions of many of the classics of that subject, such as the books by Hieronymus Mercurialis, Thomas Phaer, Robert Pemell and Walter Harris, to name only a few of those which are shown.

Some comments may be made regarding methods of feeding infants at different periods. Some of the third-century B.C. Greek feeding bottles which are shown have artistic merit. The Roman feeding vessels are of a glass of great beauty. One of the most interesting types of feeding vessels exhibited is the so-called breast-shaped feeding bottle, used by the Greek settlers in southern Italy during the three centuries before our era, of which several examples are shown. Of a complicated design, these charming bottles must have been difficult to fill and next to impossible to keep clean. In the sixteenth and seventeenth centuries feeding bottles resembled rather large spice pots, and were made in pewter. Several fine examples are shown. The early nineteenth century saw the florescence of the boat-shaped feeding bottle, with a spout at one end and an opening for filling on the upper side. Made at first in porcelain and earthenware, some had interesting designs. Wedgwood and Spode both made such types. From these to similar glass vessels was a short step. Some fine cradles of different periods are also shown, together with the 'walking-stool' which appears in paintings by the great masters as early as the sixteenth century.

As a pendant to the historical exposition, some cases are devoted to the management of the child among primitive races. The baby-carriers used by certain African tribes and by the American Indians are beautifully made. Those of the Indians consist of highly decorated pouches of hide. The feeding of infants among primitive peoples is illustrated by several carvings. One of the most interesting of these is a fine ivory from Central Africa, showing a mother suckling her child. The exhibition also contains a very interesting series of amulets, used both by primitive peoples and by Europeans up to the present day.

EAST AFRICA HIGH COMMISSION

REPORT FOR 1953

THE East Africa High Commission was constituted on December 19, 1947, to replace the East African Governors' Conference, and came into operation on January 1, 1948. It grew out of the experience of common administrative organization of the Second World War, and the scope of the Commission is due for review before the end of 1955. Its purview included on January 1, 1948, the four research organizations comprised in the East African Research Services, to which have since been added the Desert Locust Survey and Control, the East African Bureau of Research in Medicine and Hygiene, the Filariasis Research Unit, the East African Medical Survey, the Virus Research Unit, the East African Malaria Unit, the East African Inter-Territorial Leprosy Specialist and the East African Marine Fisheries Research Organization. Although the annual report of the Commission for 1953* includes as Part 3 an account of the evolution and of the constitution and scope of the Commission, out of its total of ninety-eight pages a full forty are concerned with the research and scientific services, and the record of activities thus presented is one which is of unusual interest to the scientist, whose clearly evinced support may be required if next year is to see no interruption to such services and the provision of inter-territorial financial support on an adequate scale.

During the year the East African Advisory Council on Agriculture, Animal Industry and Forestry was replaced by a Governing Body for the Natural Resources Group of the High Commission Research Services. The Body now constituted will be responsible for seeing that the activities of the four East African Research Organizations are directed to effective ends and supervising their general financial policy. To some extent the chapter of the report dealing with research and scientific services overlaps with that in "Colonial Research", but fuller accounts are given of certain activities than is possible in that report. On the other hand, the activities of the East African Industrial Research Board are covered more fully in the eleventh annual report of that Board (see *Nature*, September 4, p. 430). In the East African Agriculture and Forestry Research Organization, completion of farm buildings for the Animal Industry Division filled a main gap in research facilities, and the Plant Quarantine Station at Muguga was also completed during the year. Considerable work was carried out on breeding crop plants for resistance to disease, particular success being had with a strain of maize resistant to rust (*Puccinia polysora*). Entomological research was directed mainly towards the survey of insects attacking forest trees and timber and investigations of the more dangerous pests and the use of insecticides on field crops. Soils research was concentrated on the characteristics of a soil, determinable by analysis, that will indicate the ability of plants grown on it to respond to dressings of phosphate and nitrogen. The Veterinary Research Organization continued to work on the development of a quantitative serological test for the virus and antibodies of rinderpest, as well as field surveys of east coast fever, studies on problems of identification of the genera

* Colonial Office. Annual Report on the East Africa High Commission, 1953 (Colonial 305). Pp. ii+100+4 plates. (London: H.M.S.O., 1954.) 3s. 6d. net.

Rhipicephalus and *Hyalomma* and on paramphistomes of domestic ruminants and on the larvæ of *Haemonchus contortus*.

Good progress was made with the construction of the Central Trypanosomiasis Research Laboratory at Sukulu, Uganda, and fields-trials to determine the role of biting-flies in the spread of animal trypanosomiasis in tsetse-free country were continued, while treatment with 'Antrycide' pro-salt at two-monthly intervals for a limited period protected cattle exposed daily to attacks of the tsetse *Glossina austeni* even after cessation of treatment. Research on the race of *G. morsitans*, which occupies about a hundred thousand square miles of the western fly-belt of Tanganyika, was extended to include the race of *G. morsitans* inhabiting a different type of vegetation in some ninety thousand square miles of eastern and southern Tanganyika. Important advances in the determination of blood meals taken up by tsetse flies have been made and were due to be published.

A comprehensive collection of hydrological data from Lake Victoria by the Fisheries Research Organization indicated a significant lack of sulphates in the waters of Lake Victoria, and the complicated water movements in this lake have to some extent been related to the variable growth of plankton in different areas. Data on the growth-rate of *Tilapia* indicate that the quality of the food may be more important than the amount. Some successful fish-marking experiments were carried out in the Kavirondo Gulf, while in marine waters the Marine Fisheries Research Organization made extensive studies on pelagic fish as well as correlated investigations on the plankton or biological content and the hydrography of the area. Good progress was made on the construction of a new headquarters building for the Meteorological Department, which was occupied mainly with providing a forecast service covering East Africa and an area of the Indian Ocean and with the collection and collation of climatological records.

At the end of 1953 the total strength of the Desert Locust Control and Survey was 174 officers and 522 vehicles and, besides the major operations in the Somali Peninsula and in Kenya against the increasing extent and intensity of the plague of the desert locust, fifty swarms of which invaded British East Africa early in 1954, control measures were carried out in Aden, Yemen, Kuwait and Oman. About £1 million was expended on control and research during the year. The Filariasis Research Unit began to operate on July 1, 1949, and the report gives a brief general review of the results achieved by the Unit in its study of bancroftiasis and onchocerciasis methods of control. The reduction of staff in the early stages has necessitated an extension of the scheme before the work in East Africa can be completed. The first phase of the East African Medical Survey also terminated in December 1953. In the five years work reviewed in this report, the surveys conducted in Kenya and Tanganyika have yielded statistical data which illustrate the relation of such influences as agriculture, animal husbandry and domestic practices to the health of the community.

Early in 1953 the Virus Research Institute undertook an investigation which has elucidated the nature of dengue-like fever around Newala in south Tanganyika. Work on yellow fever was less extensive, but a survey was made at Newala ; and the Institute is also studying the inter-relation between a virus and its insect host, using rift valley fever and *Aedes aegypti*, and the relation between virus and the host's tissue, using influenza virus and the embryonated hen's egg. Although the activities of the Malaria Unit were restricted by absence of staff, an investigation of the epidemiology of malaria in Buganda was initiated, and one on residual house spraying with 'Gammexane' in the Northern Province of Tanganyika, which was concluded, indicated the uncertainty of house-spraying over a limited area as an anti-malarial measure. Use of mass house-spraying technique indicated that the total anopheline population in an area was about 40 per acre.

The Inter-Territorial Leprologist estimates that £200,000 a year over ten years would be required to attack leprosy on a broad front in all the Territories simultaneously, with good prospect of reducing it to negligible proportions in that period ; there are at present some 216,000 leprosy cases, with eighteen leprosaria and various out-patient and rural schemes. Good results are being obtained with sulphone and other specific drugs, and under the regional leprosy surveys of the Territorial Leprologist, rural leprosy work developed particularly well in Uganda.

INTERNATIONAL CONFERENCE ON ELECTRON MICROSCOPY

LONDON, 1954

DURING September 1950 an international conference on electron microscopy was held in Paris, and at an informal meeting of members of the various national groups it was decided that some international organization should be set up to arrange international conferences at regular intervals. The British Group, namely, the Electron Microscopy Group of the Institute of Physics, was asked to investigate the best method of attaining this object. Mr. F. W. Cuckow, who was secretary of the British Group at the time, approached the International Council of Scientific Unions, and it was eventually decided to set up a Joint Commission on Electron Microscopy on which the scientific unions interested in the subject would have representatives. It was the privilege of the Committee of the British Electron Microscopy Group, together with those members of the Joint Commission who could attend committee meetings in London, to organize the first International Conference under the auspices of the Joint Commission, at the London School of Hygiene and Tropical Medicine, during July 15–21. The detailed organization was carried out jointly by Mr. F. W. Cuckow (acting as secretary of the Joint Commission) and Dr. C. E. Challice (as secretary of the British Group). Office facilities were made available by the Institute of Physics. A programme committee, consisting largely of the secretaries of the national groups, was set up, with Dr. V. E. Cosslett (chairman, British Group) as its secretary. At the beginning of the conference the Joint Commission held its first meeting and before the conclusion of the conference a committee had been set up, under the Commission to co-ordinate future international meetings.

After the Conference had been formally opened, three invited survey papers were read. First, Prof. B. von Borries (Technische Hochschule, Aachen), a

pioneer in the electron microscope field, reviewed recent developments in the use of beams of fast-moving corpuscles for microscopy. Dr. F. S. Sjöstrand (Karolinska Institut, Stockholm) outlined recent advances in biological knowledge achieved with the electron microscope, and devoted most of his review to the outstanding results obtained in the past two years by the application of the ultra-thin sectioning technique, of which he himself was a pioneer. Dr. J. Nutting (Metallurgy Laboratory, Cambridge) then surveyed the developments in metallurgical, chemical and industrial applications of the instrument.

Following these three papers came the sessions of original contributions. It would be impossible to present, in the space available, even an indicative review of the 160 papers read, as the result would be merely a list of titles. In any event, in order to get through this number of papers in the five working days assigned to the meeting, parallel sessions had to be held on four of the afternoons and one morning, thus making it impossible for anyone to hear all the papers read. As the authors' abstracts are available[1] and the full proceedings are to be published[2], the scientific sessions will be reviewed here in a superficial manner only.

Electron Optics

Seven sessions were devoted to subjects which can be classified under this general heading. Two theoretical sessions, one on electron optical theory (twelve papers) and one on electron interference and phase effects (three papers), showed that more consideration is now being given to aberration theory than to general lens theory. Some interesting practical results from a 'phase-contrast' electron optical system were produced by M. Marcel Locquin (Paris). A more experimental session on ion microscopes and X-ray microscopes (six papers) included papers on a lithium ion microscope (Dr. M. Gauzit, Paris) and a proton microscope (Prof. G. Magnan and Dr. P. Chanson, Paris) together with three papers on the theory and application of the X-ray shadow microscope. Dr. R. Castaing (Toulouse) gave a summary of his work on electron probe techniques. A session on emission and reflexion microscopy (six papers) included a report from Prof. G. Dupouy and Prof. Ch. Fert (Toulouse) on reflexion electron microscopes and a description of metallurgical emission – microscopical techniques by members of the Philips Co.'s research team. Spectacular results obtained by Prof. G. Möllenstedt and Dr. M. Keller (Mosbach-Baden) were shown. Their apparatus consisted of an emission microscope in which the cathode (specimen) emission was excited by ion bombardment. Other aspects of emission microscopy were presented in three further contributions.

Three sessions devoted to the conventional type of electron microscope were all intended to be of general interest to users of the instrument. "New Electron Microscopes" (four papers) contained descriptions of two experimental instruments and two commercial models (R.C.A. and Siemens), and "Apparatus; Operation of Microscopes" (nine papers) contained descriptions of a number of pieces of experimental apparatus directly connected with the electron microscope or its use. "The Attainment of High Resolution" (three papers) provided a promise of 5 A. or so resolving powers in the foreseeable future.

Specimen Techniques

Four sessions were devoted to specimen preparation techniques. In that on general specimen techniques (eleven papers) Dr. Marcel Locquin (Paris) described how living specimens contained in a small water-containing cell can be examined in the electron microscope. A number of replica processes for different particular types of specimen were described by other workers, particularly striking results being obtained by Mr. D. E. Bradley (Aldermaston) by the use of carbon replicas. In the session on metallurgical specimens techniques (six papers) a number of methods of preparing metals and metal surfaces for examination by electron microscopy were discussed. The microtomy session contained descriptions of two new microtomes, together with a method of preparing steel knives for cutting ultra-thin sections. A symposium on the preservation of biological material contained five papers. This included two major American contributions, one by Dr. G. E. Palade (New York), whose introduction of the practice of buffering osmic acid for the fixation of tissue has been copied by practically all workers in the field, and the other by Prof. T. F. Anderson (Pennsylvania) on the preservation of structure in dried specimens. The results of Prof. Anderson's technique of taking the medium in which the specimen is suspended around its critical point were presented in a number of most impressive stereo slides.

Non-Biological Applications

The three sessions falling under this general heading showed that considerable progress has been made in this field of application since the 1950 conference. On metallurgical applications there were thirteen contributions in which it was described how the techniques of emission and reflexion microscopy have enabled a number of problems to be studied directly, without the use of replicas, while the carbon replica process has enabled the full resolving power of the conventional transmission electron microscope to be exploited. Studies on steels subjected to various treatments, together with studies on a number of non-ferrous metals, were described. Industrial, chemical and other applications (thirteen papers) referred to all non-biological work not covered by metallurgy, and included some studies on crystals, colloids, rubber, paper and gels.

A symposium on the action of the electron beam on the specimen (five papers) was concerned with the changes both morphological and chemical which take place in the specimen when the electron beam is applied.

Biological Applications

Fifty-seven papers were presented in the sessions on biological applications, and the diversity of the biological fields covered was so great that it is quite impossible to do justice in this review to the work described. Generally speaking, the contributions were dominated by the application of the thin-sectioning techniques which, at the Paris Conference in 1950, were still in their infancy. Bacteria, viruses, spermatozoa and cilia have all been sectioned and examined, together with a large number of tissue cells. Among the virus studies described (fourteen papers) were animal, plant, insect and bacterial viruses, and the bacterial studies (ten papers) covered work performed on a number of different strains of

organisms. Internal structure of cells (thirteen papers) included studies on muscle, pancreas, retina, nerve cells and yeasts. Five papers were devoted to the structure of cell and body walls, while eight papers on fibrillar structures included some interesting work on the application of the reflexion technique to the examination of fibres. Work on muscle and collagen was also described. A symposium on the microanatomy of cilia, flagella, etc., included some interesting speculations by Miss W. van Iterson (Amsterdam) on possible relationships between flagella, cilia and sperm tails.

It was interesting to note, throughout the conference, the increasing use which is being made of the stereo technique. This technique is proving of real value, as it is impossible in many specimens to obtain adequate information on spatial relationships by any other method.

In connexion with the Conference, an exhibition of commercial apparatus and books, and also of research micrographs, was held at the London School of Hygiene and Tropical Medicine; indeed, the Conference owed much of its success to the dean and staff of the School for their generous help and for making available excellent facilities.

C. E. Challice

[1] Handbook of the International Conference on Electron Microscopy, London, 1954 (obtainable from the Institute of Physics, 47 Belgrave Square, London, S.W.1).

[2] Proceedings of the International Conference on Electron Microscopy, London, 1954 (Royal Microscopical Society, London) (in the press).

THYROID FUNCTION

As part of a joint meeting with the Association of Clinical Pathologists held at the Grand Hotel, Brighton, on October 2, the afternoon session was devoted to a programme of papers on thyroid function organized by the Association of Clinical Biochemists.

The subject was introduced by Prof. E. J. Wayne (University of Glasgow), who discussed the use of radioiodide in the diagnosis of thyroid disorders. The opinion was expressed that it is preferable to use two or three tests, especially the determination of the thyroid uptake of radioiodine, four hours after a dose, and the plasma protein-bound activity forty-eight hours after a dose. The latter corresponds best with the final clinical diagnosis in cases of hyperthyroidism, while tests based on urinary excretion are specially valuable in the diagnosis of hypothyroid states.

The results of some five hundred cases in which the iodine-131 thigh-neck clearance test was employed were reviewed by Dr. B. W. Meade and Prof. N. F. Maclagan (Westminster Medical School, London). In only forty cases was there a discrepancy between the results of the test and the clinical condition. In seventeen cases which showed a high clearance-rate, sixteen were due to goitrogen administration and one to a large non-toxic goitre. The remaining anomalous results were low—eleven were due to iodide and six to thyroxine; two were post-thyroidectomy, and four were not explained.

Drs. F. Brown and H. Jackson (Christie Hospital, Manchester) then reported the results of the treatment of thyroid carcinomata with therapeutic doses of iodine-131. The plasma was found to contain thyroid protein in addition to thyroxine, and in some cases small amounts of diiodotyrosine. The results of certain animal experiments which were also reported showed that the metabolism of thyroid protein shows a definite species specificity: dog thyroid protein is not metabolized by rats, nor is that from rats metabolized by dogs.

Dr. A. Tickner (Guy's Hospital Medical School, London) discussed the serum cholinesterase level in thyroid disease. It was found to be high in thyrotoxic states and low in myxœdema, but there was some overlap. Since the liver is regarded as the source of cholinesterase, it seems that in thyrotoxicosis the cholinesterase activity is a measure of liver function.

The measurement of thyroid-stimulating hormone in thyroid disorders was reported by Dr. I. C. Gilliland (Postgraduate Medical School, London), who found that the level is high in myxœdema and low in Simmond's disease, whereas in thyrotoxicosis it is low unless eye signs are present, when it is raised. In cases of exophthalmos without thyroid involvement, there is no increase in the thyroid-stimulating hormone-level. Dr. Gilliland therefore concludes that more than one factor is involved.

Drs. A. L. Tárnoky and P. White (Royal Berkshire Hospital and University of Reading) have investigated the relationship between a number of conventional tests in thyroid disease. Highly significant correlations were found between the basal metabolic rate, the serum cholesterol and the urinary pigment: creatinine ratio.

The last paper was by Mr. C. H. Bowden, Prof. N. F. Maclagan and Dr. J. H. Wilkinson (Westminster Medical School, London), who described the application of the ceric sulphate – arsenious acid reaction to the detection of thyroxine and triiodothyronine in plasma. An outline of the techniques employed for the extraction of the protein-bound iodine components from normal plasma and their detection on paper chromatograms was given. Preliminary results indicate that thyroxine and triiodothyronine are components of both normal and thyrotoxic plasma.

J. H. Wilkinson

PERTURBING ACTION OF THE EARTH ON METEOR STREAMS

A PAPER discussing a criterion concerning the perturbing action of the earth on meteor streams by L. Kresák, of the Astronomical Observatory of the Slovak Academy of Sciences, Skalnaté Pleso (*Bull. Astro. Inst. Czechoslovakia*, **5**, No. 3; 1954), deals with the possibility of the dispersion of meteor streams by the earth. He makes use of Tisserand's well-known criterion for the identity of comets which are perturbed by a comparatively close approach to a planet; this states that

$$1/a + 2\sqrt{a(1 - e^2)}\cos i = C,$$

where a, e and i have the usual significance in dynamical astronomy. He then develops another criterion, the earth being the disturbing body and a meteor stream taking the place of a comet. The treatment has some advantages: for example, geocentric velocities of meteors can be determined more directly than orbital elements involved in Tisserand's criterion, and also they can be obtained directly by means of radio-echo technique. After a few substitutions and transformations of the above equation, it can be expressed in the form:

$$1/a + 2\sqrt{a(1 - e^2)}\cos i = 3 - w^2,$$

where w is the geocentric velocity of the meteor; as the left-hand side of this equation is the Tisserand invariant C, the expression on the right is also constant. This shows that the geocentric velocity of a meteor is unaffected by the earth's perturbations and remains unaltered for each next encounter with the earth; the velocity vector may undergo only a reorientation. While the perturbations of the major axis may be considerable for those meteors which just escape the atmosphere, yet they appear only in a displacement of the radiant, the change of heliocentric velocity being compensated by the change of elongation of the radiant from the apex of the earth's way. In the case of meteors reaching the point of nearest approach ahead of the earth, the true and apparent radiants are shifted nearer the apex; but if the nearest approach is behind the earth, they are shifted farther from the apex.

The matter is very fully discussed in the paper and attention is concentrated on eleven of the most important meteor showers; if any observable results of the earth's action are to be found, they should be detectable in four favourable cases—in the constitution of the Taurids, Geminids, Quadrantids and Delta Aquarids—but the investigations show that the distribution of geocentric velocities does not satisfy the condition expressed above by Tisserand's equation. The conclusion is that meteor orbits are dispersed in an entirely different way from what would be expected by the earth's action. Nor can the Poynting–Robertson effect have been responsible for the arrangements of meteor orbits within the streams, and the only single factor that can be held responsible is the occasional local perturbations by the major planets acting from the time when the particles became dispersed along a portion of the original orbit.

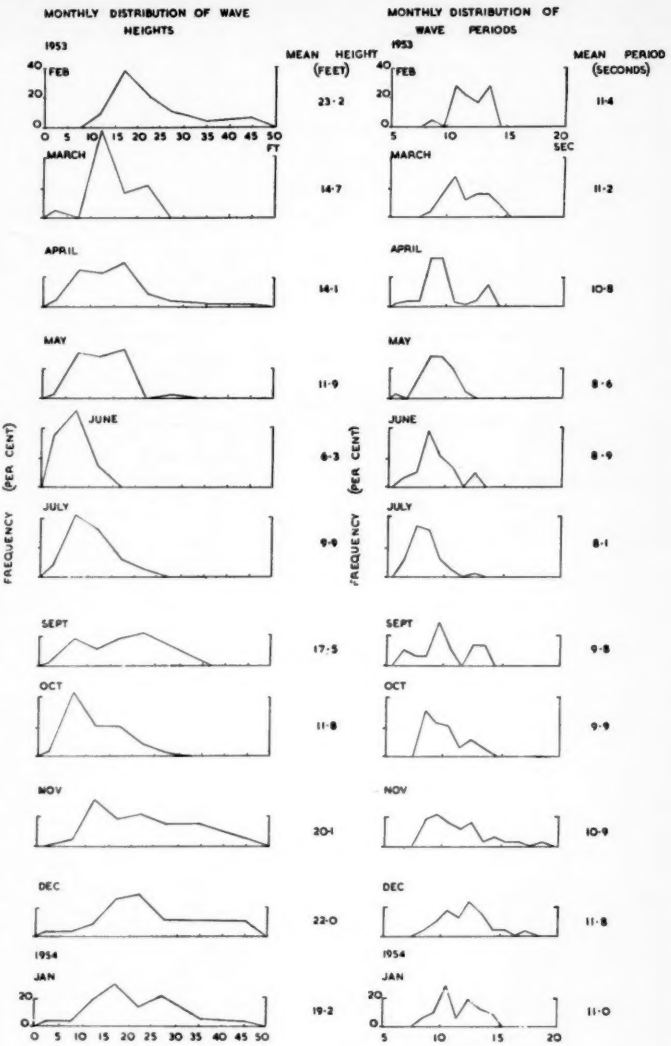

Fig. 1

WAVE CONDITIONS IN THE NORTH ATLANTIC, 1953–54

By J. DARBYSHIRE

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WAVES have been recorded regularly in the North Atlantic Ocean by the Ocean Weather Ship *Weather Explorer* since February 1953. Wave recordings of about 8–10 min. duration are taken eight times daily using the ship-borne wave recorder already described by Tucker[1]. Sufficient results are now available to form a statistical summary of the wave characteristics.

The *Weather Explorer* occupies in turn the positions 'India' (61° 00′ N., 15° 20′ W.) and 'Juliet' (52° 30′ N., 20° 00′ W.), and observations at both positions have been combined as being representative of wave conditions generally in this part of the Atlantic Ocean. No records were obtained in August. The records were examined and the maximum height and the significant wave-period found. The significant wave-period is the mean period of the highest one-third of the waves recorded. The wave characteristics are summarized in Tables 1 and 2 and Fig. 1. Table 1 shows the percentage of time the maximum wave height is greater than 40 ft., between 30 and 40 ft., 25 and 30 ft., 20 and 25 ft., 15 and 20 ft., 10 and 15 ft., 5 and 10 ft., and less than 5 ft., for each month from February 1953 to January 1954, also the mean significant period of the waves which fall

Table 1. Distribution of Wave-Heights

Wave-height (ft.)		Feb.	Mar.	April	May	June	1953 July	Aug.	Sept.	Oct.	Nov.	Dec.	1954 Jan.
40–50	% Frequency	11·1	0	1·9	0	0	0		0	0	6·1	10·6	3·6
	Mean period (sec.)	13·0	—	13·0	—	—	—		—	—	15·0	13·8	13·0
30–40	% Frequency	5·5	0	1·9	0	0	0		7·7	0	10·2	10·6	7·2
	Mean period (sec.)	13·5	—	13·5	—	—	—		12·0	—	12·4	12·8	13·5
25–30	% Frequency	11·1	0	3·8	2·9	0	0		15·4	2·9	10·2	10·6	21·4
	Mean period (sec.)	12·0	—	13·3	10·5	—	—		12·3	13·0	12·7	13·8	12·0
20–25	% Frequency	22·2	21·9	9·6	0	0	5·0		23·1	8·8	20·4	29·0	14·3
	Mean period (sec.)	11·0	12·0	10·8	—	—	10·3		11·1	11·2	10·7	10·7	10·0
15–20	% Frequency	38·9	15·6	30·8	34·4	0	12·5		19·2	20·6	18·4	26·3	28·6
	Mean period (sec.)	11·5	12·0	9·3	9·3	—	8·3		9·2	10·9	11·2	11·2	10·7
10–15	% Frequency	11·1	59·5	23·1	28·6	13·8	32·5		11·5	20·6	30·6	7·9	17·8
	Mean period (sec.)	10·0	10·7	9·7	9·1	8·6	7·9		9·2	9·6	9·2	11·2	12·3
5–10	% Frequency	0	0	25·0	31·4	52·0	42·5		19·2	44·0	4·1	2·6	3·6
	Mean period (sec.)	—	—	9·0	8·3	8·7	7·3		7·2	9·2	9·0	10·0	9·0
0–5	% Frequency	0	3·5	3·8	2·9	34·4	7·5		3·8	2·9	0	2·6	3·6
	Mean period (sec.)	—	14·0	5·5	5·0	9·3	9·0		6·0	10·5	—	10·5	6·0
Mean maximum height (ft.)		23·2	14·7	14·1	11·9	6·3	10·0		17·5	11·8	20·1	22·0	19·2

Table 2. Distribution of Wave-Periods

Wave-period (sec.)		Feb.	Mar.	April	May	June	1953 July	Aug.	Sept.	Oct.	Nov.	Dec.	1954 Jan.
> 14	% Frequency	0	9·4	0	0	0	0		0	0	12·2	13·0	10·7
	Mean height (ft.)	—	8·0	—	—	—	—		—	—	28·6	32·4	18·0
13–14	% Frequency	27·8	15·6	15·4	0	0	0		15·4	5·8	2·0	15·8	14·3
	Mean height (ft.)	31·0	18·4	23·3	—	—	—		24·5	22·5	46·0	31·7	21·0
12–13	% Frequency	16·7	15·6	3·8	0	10·3	2·5		15·4	11·6	16·3	23·7	21·4
	Mean height (ft.)	22·0	17·6	16·5	—	2·8	2·5		27·3	15·8	26·0	20·2	21·0
11–12	% Frequency	22·2	12·5	1·9	5·8	0	0		0	5·8	12·2	13·2	7·2
	Mean height (ft.)	21·5	15·0	11·0	15·0	—	—		—	19·8	22·0	17·8	18·0
10–11	% Frequency	27·8	28·2	3·8	20·0	13·8	5·0		11·5	20·6	16·3	18·4	28·6
	Mean height (ft.)	17·0	14·9	11·0	15·3	6·0	22·0		22·0	10·9	20·0	16·5	18·0
9–10	% Frequency	0	15·6	32·7	28·6	20·6	12·5		30·8	23·2	21·4	10·5	10·7
	Mean height (ft.)	—	12·0	15·8	13·5	6·0	12·6		14·3	10·7	15·1	19·8	11·0
8–9	% Frequency	5·5	3·5	32·7	28·6	38·0	32·5		7·7	32·4	18·4	5·2	7·2
	Mean height (ft.)	17·0	10·0	10·9	11·5	7·4	9·5		13·5	8·8	12·3	18·5	16·0
< 8	% Frequency	0	0	9·5	17·2	17·2	47·5		19·2	0	0	0	0
	Mean height (ft.)	—	—	6·2	6·7	4·7	8·4		8·3	—	—	—	—
Mean period (sec.)		11·4	11·3	10·8	8·6	8·9	8·1		9·8	9·9	10·9	11·8	11·0

within these height-ranges. The overall mean maximum height for each month is given in the last row.

Table 2 gives a similar survey of wave-periods, the period classes being greater than 14 sec., 13–14 sec., 12–13 sec., 11–12 sec., 10–11 sec., 9–10 sec., 8–9 sec., and less than 8 sec. The mean maximum height for waves falling in these period ranges is given, and in the last row the mean significant period for all the waves recorded during the month.

A comparison of this statistical summary with a similar one for waves recorded off Perranporth, Cornwall, during February 1946–January 1947 will be published shortly; but briefly, the comparison shows that the waves are much higher in the open ocean, the highest percentage frequency for waves of more than 20 ft. for any month at Perranporth being only 5 per cent. Longer wave-periods are, however, more frequent at Perranporth, waves with significant periods of more than 14 sec. being present for 45 per cent of the time during January 1947.

An explanation of the effect of shorter period and greater height may be found by considering the wave spectrum. It has been shown[2] that storm waves consist of a mixture of waves of various periods, and that the energy of the waves of shorter period does not increase indefinitely as the wind increases but actually tends to decrease, waves of longer period being favoured. Recent investigation has shown that this effect is not nearly so marked in the open ocean, where, as the wind increases in strength, the energy of the waves of shorter period continues to increase so that a greater proportion of the wave energy is contained in these periods. This effect would tend to reduce the mean period and increase the height. A more detailed account of this investigation will be published later.

I wish to thank the Director of the Meteorological Office and the Superintendent of the Marine Division for their co-operation; also the Master, Senior Meteorological Observer and crew of the *Weather Explorer* for making the observations.

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SYNTHETIC ACTIVITY OF A SINGLE EPITHELIAL CELL OF THE LACTATING GOAT UDDER

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It would be interesting to have quantitative information about the average synthetic activity of individual cells of secretory organs in the animal body; but the work done by a single mammalian

cell is not easy to estimate. The mammary gland is a secretory organ which possesses outstanding capabilities for the synthesis of protein (mainly casein), fat and carbohydrate (lactose). The development by one of us (K. C. R.) of a method for estimating the total surface area of alveolar epithelium in the goat udder makes it possible to calculate the average rate of secretion (that is, synthesis) of the three principal milk constituents by a single mammary epithelial cell in this species.

The average output of milk by the individual epithelial cells of the goat udder was calculated from the total area of epithelium lining the alveoli and intra-lobular ducts of a single mammary gland (the goat udder consists of two mammary glands), the average cross-sectional area of the individual epithelial cells and the average weekly milk yield of the gland.

The method for calculating the total area of secretory epithelium in a half-udder of the goat has already been described[1], together with results from a series of sixteen ovariectomized goats brought artificially into lactation by the administration of sex hormones and three control goats in normal lactation following pregnancy. The same sixteen experimental glands and one control have been used for the present estimations.

To determine the average cross-sectional area of the mammary cell, areas of alveolar epithelium cut tangentially to the wall of the alveolus were measured by outlining groups of cells cut in this plane and through the level of their nuclei at a constant magnification of × 1,200. The area of each group measured by a planimeter was then divided by the number of cells within the group and finally corrected for the magnification. Sufficient estimations were made from five sections of lobule-alveolar tissue, taken at random, for an average of 150 cells to be measured in each gland.

Table 1 gives the data from which the output of milk per cell per hour has been calculated. Taking the mean value for the average output of milk per cell per hour, 23×10^{-11} ml./cell/hr., and using average figures obtained by Rowland[2] for the composition of the milk of British Saanen goats from the same herd as follows: fat, 3·91 per cent; casein, 2·41 per cent; lactose, 4·07 per cent, the amounts of each constituent synthesized per cell per second calculated as outlined above are given in Table 2. In the case of lactose, the number of molecules synthesized per second can readily be calculated from this value. The figure given in the last column of Table 2 shows that the epithelial cell of the goat udder synthesizes about $4·5 \times 10^6$ lactose molecules per second.

Table 1. Milk Output of a Single Epithelial Cell of the Lactating Goat Udder

Goat No.*	Weight of half udder after fixation* (gm.)	Surface area of total secretory epithelium* ($m.^2$)	Average cross-sectional area of epithelial cell (μ^2)	Average weekly milk yield (l.)	Output of milk per cell per hour (ml. $\times 10^{-11}$)
258 *b*	610·0	11·78	78·5	5·2	21
264 *b*	184·5	2·99	109·9	1·7	36
271 *b*	290·0	4·76	101·0	1·2	15
273 *b*	428·0	7·97	138·7	2·5	26
323 *b*	458·5	6·41	122·8	1·6	18
383 *b*	735·0	10·15	122·3	4·1	29
391 *b*	336·0	5·10	76·3	2·0	18
259 *b*	396·5	7·06	123·0	2·6	27
289 *b*	517·5	10·74	86·5	4·1	20
270 *b*	324·0	6·39	115·1	2·4	26
257 *b*	744·0	14·05	86·3	5·4	20
326 *b*	841·0	16·72	111·0	5·8	23
384 *b*	558·0	13·25	146·5	4·2	28
394 *b*	278·5	6·45	132·3	2·2	27
316 *b*	916·0	15·51	68·3	4·7	12
338 *b*	497·5	11·34	114·6	2·7	16
401 *a*, 401 *b*	1186·0	33·47	137·7	12·1	29
				Mean:	23

* See ref. 1

Table 2. Rate of Synthesis of Major Milk Constituents by a Single Cell of the Lactating Goat Udder

	Per cent in milk	μgm. synthesized/ cell/sec.	Molecules synthesized/ cell/sec.
Lactose	4·0	$2·6 \times 10^{-9}$	$4·5 \times 10^6$
Fat	3·9	$2·5 \times 10^{-9}$	$4·1 \times 10^{6*}$
Casein	2·4	$1·5 \times 10^{-9}$	

* Saturated fatty acid molecules from butyric to palmitic, assuming all are synthesized from small molecules.

The problem of calculating the number of molecules of fatty acids synthesized per cell in a given time is a little more complicated, since goats' milk glycerides contain a 'spectrum' of fatty acids of chain-length from C_4 upwards. There is considerable evidence (see Folley[3]) that synthesis from acetate in the udder itself plays an important part in the formation of the fatty acids of milk fat, at least of the saturated series from butyric up to and including palmitic, though it is believed that oleic and stearic acids of milk fat arise principally from the blood glycerides. Taking the figures given by Gamble, Ellis and Besley[4] for percentages of the various fatty acids in the total fatty acids of goat milk fat and assuming that the total fatty acid content of goats' milk fat is of the order of 90 per cent, the numbers of molecules of each saturated fatty acid from butyric to palmitic synthesized by a single cell each second were therefore calculated on the assumption that the whole of these acids are synthesized in the udder from acetate. The total, just over 4×10^6 molecules per second, happens to be very close to the figure for lactose. If one accepts the mechanism for the synthesis of milk fatty acids postulated by Popják, French, Hunter and Martin[5], namely, that they are formed by successive condensation of 2-carbon units, and neglecting any utilization of preformed 4-carbon units entering from the blood which would scarcely affect the calculation, the figure obtained for the rate of synthesis of the saturated fatty acids (C_4–C_{16}) corresponds to about $21·5 \times 10^6$ condensations/sec./cell.

No attempt has been made to calculate the rate of synthesis of casein molecules owing to uncertainty about the molecular weight of casein.

It should be pointed out that the figures given in Table 2 represent average rates of synthesis calculated over twenty-four hours. The rate of milk secretion is, however, not constant; it is relatively rapid just after milking and then slows down as the udder fills with milk. The maximum rates are therefore certain to be considerably greater than the average rates given in the table. [Aug. 13.

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LETTERS TO THE EDITORS

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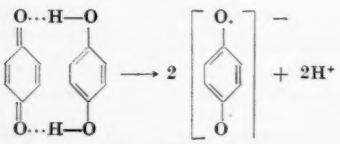
Stabilization of Free Radicals by Adsorption : Detection by Paramagnetic Resonance

It is known that quinhydrones are weak acids and may therefore form ions in strongly alkaline solutions. Due to the loss of two hydrogen atoms of the quinhydrone compound, two identical semiquinone ions can be expected ; for example :



(I) Quinhydrone (II) Semiquinone

These semiquinone ions, having an odd number of electrons, should be paramagnetic. Michaelis has proved the existence of free radical ions of this type during alkaline reduction of phenanthrene-quinone-3-sulphonate[1] by potentiometric and magnetic measurements. It would be difficult to demonstrate the existence of free radical ions in the case of many quinhydrones, for example, *p*-benzoquinhydrone, as they are too unstable in alkaline solution. It occurred to us, however, that it might be possible to stabilize such unstable radical ions by adsorption of quinhydrone on suitable basic surfaces. A sufficiently basic surface could have the same effect as the alkaline solution, and the adsorption might stabilize the free radicals formed.

To test this idea we adsorbed *p*-benzoquinhydrone on barium hydroxide octahydrate, using solutions in various non-polar solvents (dioxane, benzene). An intense blue colour appeared on the surface. Solutions of pure *p*-benzoquinone and pure hydroquinone gave rise to no colour on adsorption, nor was this colour formed when alumina or silica gel was used for adsorption of *p*-benzoquinhydrone.

Paramagnetic resonance[2,3] experiments on the coloured surface showed it to be paramagnetic. Our measurements were made on the powder at 90° K. Neither barium hydroxide nor solid *p*-benzoquinhydrone alone showed paramagnetism. The paramagnetic resonance consisted of a single absorption line, a few gauss wide and with $g = 2{\cdot}003 \pm 0{\cdot}001$. This is typical of the resonance obtained from a free radical. Thus it seems reasonable to conclude that our experiments demonstrate the formation and stabilization of free radical semiquinone ions on an alkaline surface.

Since quinhydrone splits up into a rather complicated equilibrium system in solution[4], a similar situation may arise on the barium hydroxide surface, and other paramagnetic ions and molecular compounds may be present. Because the paramagnetic resonance spectra of different free radicals are so similar, we cannot conclude from our experiments that only ions of one type, such as (II), are formed.

It is noteworthy that anhydrous barium hydroxide is only slightly coloured by a solution of *p*-benzoquinhydrone. If, however, one adds a few drops of water to the solution, the deep colour appears at once. Thus it seems that the hydrate water molecules are necessary to promote adsorption and formation of ions. A similar case of the effect of water on the production of coloured surfaces has been reported by Schoenberg[5]. We think this is because the strong dipole moment of the water molecules facilitates dissociation.

We have also adsorbed three other quinone-hydroquinone systems on barium hydroxide and investigated the paramagnetism. Table 1 shows the combinations on which we have made measurements, dioxane being used as a solvent. In all cases a deeply coloured surface was formed. Paramagnetism was present in all cases, even with phenanthrenequinone when the corresponding hydroquinone was not used. Here the formation of two different radical ions is to be expected, but our experiments do not distinguish between different types of radical. Adsorbed anthrarufin and quinizarin did not show paramagnetic resonance. This is not surprising ; paramagnetism is not expected, since these compounds can form a quinhydrone system within the molecule.

Table 1

Quinhydrone system Quinone	Hydroquinone	Colour after adsorption	
p-Benzoquinone	*p*-Benzohydroquinone	Deep blue	Paramagnetic
Thymoquinone	Thymohydroquinone	Blue-green	,,
Phenanthrenequinone	Phenanthrenehydroquinone	Green	,,
Phenanthrenequinone	*p*-Benzohydroquinone	Blue-green	,,
Anthrarufin		Purple	No paramagnetic resonance
Quinizarin		Purple	,,

The paramagnetism found in our experiments indicates that the adsorbed molecules lose hydrogen ions to the alkaline surface. It is interesting that Weitz[6] found that the colourless triaminotriphenylmethanol (a weak base) is adsorbed on silica gel, which is acidic, with nearly the same colour as the corresponding dye salt. He ascribes this to the formation of ions by loss of hydroxyl ions to the surface.

Goldschmidt and Christmann[7] studied the reaction of quinhydrones with sodium methylate and obtained unstable blue products which contain about two sodium atoms per quinhydrone molecule. We consider it possible that Goldschmidt's products contain ions similar to the radical ions we have obtained on the coloured surfaces. In this case one should consider them as free-radical salts.

It may be that a stabilization of free radicals on a suitable surface occurs in biological systems. For example, Kaye and Stonehill[8] give polarographic evidence that many substances of physiological importance form unstable free radicals, and they stress the importance of these in biochemical processes. Such radicals might be stabilized by acidic or basic surfaces, for example, suitable proteins.

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Isotopic Exchanges and the Existence of Tricalcium Phosphate in Bone

The problem of the physico-chemical constitution of the skeleton has received considerable attention in recent years[1–3]. Tracer experiments indicate that phosphorus-32 and calcium-45 appear promptly and in considerable proportions in the bony tissues, whence they are removed slowly[4–6]. These observations have led to an assumption that deposition of phosphorus-32 and calcium-45 in bony tissues is an exchange between bone and blood inorganic phosphate or calcium. Phosphorus-32 and calcium-45 have been used to study phosphate or calcium exchange between powdered bone and aqueous disodium hydrogen phosphate and calcium chloride solutions[7–9]. Different authors[8,10,11] have concluded that the principal bone component is not tricalcium phosphate but rather hydroxylapatite to which phosphoric ions are adsorbed in such a quantity that the ratio of calcium to phosphorus is equal to 1·94, which is the characteristic value for tricalcium phosphate. On the other hand, the findings of some workers[1,2] support the idea of the existence of tricalcium phosphate in bony tissues. The experiments reported here are an attempt to study the exchange mechanism of both phosphate and calcium between pure tricalcium phosphate and radioactive phosphate or calcium solutions. These experiments were also performed in order to show to what extent the isotopic exchange method can help to elucidate a particular problem of structural chemistry. (Calcium-45 was prepared by neutron bombardment in the pile at the Clinton Laboratories, Oak Ridge, Tenn., and phosphorus-32 at the pile at Harwell, Berks.)

In the first series of experiments, the tricalcium phosphate was prepared by mixing disodium hydrogen phosphate and calcium chloride in the presence of ammonia. Later, the tricalcium phosphate was prepared as follows: calcium oxide dissolved in water was added to dilute phosphoric acid with phenolphthaleine as indicator; the excess of calcium hydroxide was neutralized by one or two drops of dilute phosphoric acid. Phosphate was determined by the method of Fiske and SubbaRow. Calcium determinations were done by precipitation as calcium oxalate and titration by means of potassium permanganate. Radioactive measurements were made with a thin-wall end-window counter tube.

125 mgm. samples of tricalcium phosphate were exposed to 5 ml. of radioactive disodium hydrogen phosphate or calcium chloride solutions for increasing lengths of time up to sixty days. The sealed 'Pyrex' tubes containing the samples were rotated end to end continuously at 40 r.p.m. In most experiments the tests were repeated several times. Experiments were performed at 18°, 60°, 120° and 180°. The quantities of calcium or phosphorus in both phases were the same. 100 per cent of the calcium-45 and phosphorus-32 was in the solution initially and 0 per cent was in the tricalcium phosphate. At the end of each reaction period, solid and solution were separated by filtration; the same results are obtained when separation is performed by dialysis. The solid was dissolved in 5 ml. of hot 3 *N* hydrochloric acid and aliquots were taken for chemical and radioactive measurements. All the samples were counted after evaporation to dryness under an infra-red lamp. The extent of exchange was calculated in the usual manner from the specific activities of the two fractions. Some calcium phosphate samples were equilibrated for three days at 18° or 180° with radioactive solutions, at which time the latter were replaced with inert phosphate or calcium solutions and further equilibrated for an additional three days. The exchange was also studied with tricalcium phosphate ignited at 900°.

Typical results are shown in Fig. 1. For each temperature, the exchanged fraction increases rapidly in the first two hours; this rapid increase is succeeded by a much slower increase. Analytical determinations indicate that the deposition of calcium-45 and phosphorus-32 in the calcium phosphate had not been accompanied by a proportionate net deposition of the non-radioactive calcium or phosphate. No linear relationship was apparent when the logarithms of the differences between percentages exchanged at any time and at 'equilibrium' are plotted as ordinates

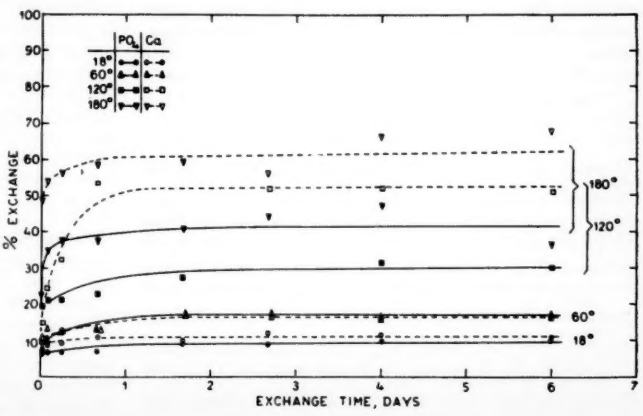

Fig. 1

against time. The exchange results do not obey a simple exponential law; it is possible to obtain curves analogous to radioactive decay curves.

The curves obtained indicate three processes to each of which corresponds a half-time for the exchange. The exchange percentages are increased with temperature. Temperature variations affect such processes as recrystallization and self-diffusion. At room temperature, the exchange could be attributed partly to adsorbed phosphoric ions ($\simeq$ 10 per cent); it cannot explain, however, the important exchange at higher temperatures. For temperatures higher than 60°, the calcium exchange is greater than the phosphate.

Results indicate a marked lack of reversibility, which is to be expected when recrystallization takes place. Ions fixed in the interior of the newly formed crystals are no longer available for exchange. Similar results were obtained by Neuman[8] with fresh bone, whereas ashed bone showed such a reversibility as reported by Falkenheim[7,9].

A lack of exchange is observed with tricalcium phosphate ignited at 900° and with large crystals of hydroxylapatite. Again, crystals are affected by heat treatment, which results in crystal growth and a more stable crystal lattice.

The time exchange curves were somewhat different for the individual phosphate preparations. Isotopic exchange, at least in the rapid exchange process, is concerned with crystal surfaces which will vary considerably for different calcium phosphate preparations. Also, heat treatment results in crystal growth, which reduces the crystal surface and at the same time the exchange. Furthermore, the exchange of both calcium and phosphate ions may involve other mechanisms such as recrystallization and self-diffusion.

When radioactive phosphate and calcium are administered to animals, it is clear that the mechanisms by which these ions are fixed by the skeleton are complex. It would be difficult to estimate the rates at which real exchange and both recrystallization and self-diffusion take place *in vivo*.

The lack of exchange by large crystals of hydroxylapatite, the same behaviour of both calcium and phosphate ions at 18°, and the important exchange observed at higher temperatures, seem to exclude that the exchange concerns adsorbed phosphate ions already present in the solid phase when experiments are started. Hence our results cannot support the assumption that the principal bone component is hydroxylapatite, which adsorbs phosphate enough to give a calcium/phosphorus ratio of 1·94.

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Isolation and Structure of an *N-iso*Butyldienediynamide from Pellitory (*Anacyclus pyrethrum* DC.)

The roots of the North African plant *Anacyclus pyrethrum* DC. (pellitory) have been used in medicine since the time of Dioscorides, and mention of the drug is made in the B.P.C. 1934 (*Pyrethri radix*). It induces copious salivation when chewed and gives rise to an intense burning taste. In a recent investigation it has been found[1] that the crystalline sialogogue isolated by Gulland and Hopton[2] from this material, and named pellitorine (melting point 72°), is in fact a mixture of *iso*butylamides[3,4] of the general type

$$R.CH{=}CH.CH{=}CH.CO.NHCH_2CH(CH_3)_2. \quad (1)$$

Hydrogenation and acidic hydrolysis yield a mixture of decanoic, dodecanoic and tetradecanoic acids which can be separated by reversed-phase partition chromatography. Its nature will be discussed more fully elsewhere. During the isolation of pellitorine, a new crystalline substance of melting point 121° has been obtained, which crystallizes from chloroform–petrol in white needles. Unlike pellitorine, it is but sparingly soluble in petrol, has no sialogogue effect and only low insecticidal activity towards the grain insect *Tenebrio molitor* L.

The new substance, 'anacyclin', has the empirical formula $C_{18}H_{25}ON$ (found: C, 79·7; H, 9·2; N, 5·2. $C_{18}H_{25}ON$ requires C, 79·9; H, 9·3; N, 5·15 per cent. Molecular weight (Rast) 284), and absorbs 6 mol. of hydrogen on catalytic hydrogenation to give dodecahydroanacyclin, melting point 66°. The infra-red spectrum (paraffin mull) indicates that this is a saturated monosubstituted amide (NH str. 3,310, 3,075; amide *A* carbonyl 1,641; amide *B* 1,548 cm.$^{-1}$), while the spectrum of anacyclin itself is characteristic of a monosubstituted amide conjugated with a diene system (NH str. 3,300, 3,060; amide *A* carbonyl 1,625; amide *B* 1,544; C=C str. 1,655, 1,612 cm.$^{-1}$). The ultra-violet absorption ($\lambda_{max.}$ 259 mμ, $\varepsilon_{max.}$ 33,500) is in agreement with data expected for a chromophore —CH=CH.CH=CH.CO.NH—. Hydrolysis of dodecahydroanacyclin gave *iso*butylamine (hydrochloride) and tetradecanoic acid (*p*-bromophenacyl ester), and its identity as *N-iso*butyltetradecanamide was confirmed by synthesis. Anacyclin itself gave *iso*butylamine on hydrolysis, so the structural problem resolves itself into placing unsaturation equivalent to four molecules of hydrogen in the chain of the acid fragment, and clarifying the stereochemistry.

Anacyclin gave an adduct with maleic anhydride (melting point 193° decomp.) which on catalytic hydrogenation absorbed five molecules of hydrogen. In this adduct the dienamide chromophore is eliminated, and when its ultra-violet absorption spectrum was determined, a series of bands became apparent ($\lambda_{max.}$ 227; 237; 252; 266; 281 mμ. $\varepsilon_{max.}$ 1,850; 1,300; 1,100; 1,000; 850). These are characteristic of a diyne containing about 4 per cent of enediyne impurity. Confirmation of acetylenic linkages was obtained from the presence of two weak C≡C str. bands in the infra-red (2,233 and 2,206 cm.$^{-1}$). Their weakness is consistent with lack of conjugation with a polar grouping. The maleic adduct had weak bands at 2,243 and 2,208 cm.$^{-1}$.

The position of the diyne system was determined by oxidative degradation with permanganate. This yielded *N-iso*butyloxamic and succinic acids, together

with butyric acid (*S*-benzylthiuronium salt) and leads to structure (2):

$$CH_3(CH_2)_2.C{\equiv}C.C{\equiv}C.CH_2CH_2.CH{=}CH.CH{=}CH.CO.NHCH_2CH(CH_3)_2. \quad (2)$$

The formation of an adduct with maleic anhydride indicates a *trans-trans*-configuration for the 2 : 4-diene system. Unpublished reference data[1] obtained from a recent study of the four stereoisomeric *N-iso*-butyldeca-2 : 4-dienamides show that the position of the C=C stretching frequencies in anacyclin, the possession of a band at 996 cm.$^{-1}$ and the absence of one at 960–965 cm.$^{-1}$, are characteristic of the above configuration. The ultra-violet extinction coefficient of anacyclin is also in agreement. Anacyclin is thus *N-iso*butyltetradeca-*trans*-2 : *trans*-4-diene-8 : 10-diynamide.

If methyl deca-2 : 4-diynoate is semi-hydrogenated in the presence of quinoline, using lead-poisoned palladium catalyst[5], the main product is methyl deca-*cis*-2 : *cis*-4-dienoate[1]. When anacyclin is allowed to absorb two molecules of hydrogen under these conditions a waxy crystalline product can be isolated which, on the basis of the above information and its ultra-violet absorption, is formulated as *N-iso*butyltetradeca-*trans*-2 : *trans*-4 : *cis*-8 : *cis*-10-tetraenamide. This unstable compound is very soluble in light petrol, is a strong sialogogue and has a high toxicity towards *T. molitor*. The last finding is of considerable interest because of the light it throws on the structure and stereochemical requirements for a potent polyene-amide insecticide.

The insecticidal testing was carried out by Dr. M. Elliott and Mr. P. Needham, Department of Insecticides and Fungicides, Rothamsted Experimental Station.

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Isolation and Structure of Neo-Herculin from *Zanthoxylum clava-herculis* L.

Southern prickly ash bark (*Zanthoxylum clava-herculis* L.) contains a potent insecticidal substance, which was named herculin (m.p. 59–60°) by Jacobson[1] and claimed to have structure (I). This structure has been disproved[2,3] by syntheses of the four possible stereoisomers of (I), which have different physical characteristics and negligible physiological activity.

(I) $CH_3CH_2CH_2.CH{=}CH.CH_2CH_2CH_2CH_2.CH{=}CH.CO.NHCH_2CH(CH_3)_2.$

(II) $CH_3CH{=}CH.CH{=}CH.CH{=}CH.CH_2CH_2.CH{=}CH.CO.NHCH_2CH(CH_3)_2.$

A highly unstable but pure compound (m.p. 70°) named *neo*-herculin has now been isolated from the bark and shown to have structure (II). It is very toxic to *Tenebrio molitor* and houseflies and seems to be the major crystalline insecticidal substance present. *neo*-Herculin has the empirical formula $C_{16}H_{25}ON$ (found: C, 77·3; H, 10·2; N, 5·7. $C_{16}H_{25}ON$ requires: C, 77·65; H, 10·2; N, 5·65 per cent) and on microhydrogenation absorbs 3·75 mol. of hydrogen. A mono-substituted amide linkage is present (infra-red absorptions: NH, 3,260, 3,070; amide *A*, C=O, 1,626; amide *B*, 1,559 cm.$^{-1}$). *neo*-Herculin gave *iso*butylamine (hydrochloride, chloroplatinate) on acidic hydrolysis: this demonstrates that unsaturation is contained only in the acid fragment. The carbon skeleton is revealed by the identity of octahydro *neo*-herculin (m.p. 53–54°) with lauric *iso*butylamide.

Ultra-violet light absorption data ($\lambda_{max.}$ 259, 269, 280 mμ; $\varepsilon_{max.}$ 31,500; 43,500; 36,200) demonstrate a conjugated triethenoid chromophore. Subtraction of the curve for α-elaeostearic acid leaves an absorption of λ 9,000 at ε 227 mμ, and this indicates that the fourth double bond is to be found α to the amide linkage. Its position is confirmed by the strength of the ethenoid stretching vibration at 1,670 cm.$^{-1}$ in the infra-red[2]. Location of the triene system in the chain was effected by ozonolysis, which yielded acetaldehyde. *neo*-Herculin is therefore N-*iso*butyldodeca-2 : 6 : 8 : 10-tetraenamide (I).

Infra-red observations suggest that the αβ-double bond is *trans*-, but the stereochemistry of the triene system cannot be completely defined. *neo*-Herculin does not give a crystalline derivative with maleic anhydride, so two contiguous *trans*- linkages are likely to be absent. The relatively low extinction coefficients in the ultra-violet are consistent with this view[4].

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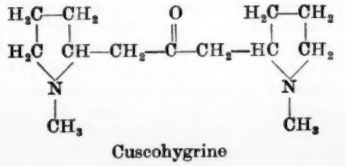
Cuscohygrine, a Normal Constituent Alkaloid of *Atropa belladonna*

In an earlier communication on alkaloids in germinating seeds of *Atropa belladonna*[1], we mentioned that a new alkaloid was the first to appear on paper chromatograms using Dragendorff's reagent. As this alkaloid was always found on chromatograms of extracts of fresh root material and no information about its nature was available, it seemed worth while to make a further investigation.

Starting with 20 kgm. dried roots, about 100 mgm. of a picrate was obtained, which was analysed: melting point, 215° C.; molecular weight, 230; elementary analysis, C, 44·7, H, 4·5, N, 16·1 per cent.



Cuscohygrine

These results, combined with decomposition experiments, which showed it to be a pyrrolidine derivative, led to the conclusion that the substance was cuscohygrine, hitherto only found accompanying coca alkaloids.

This fact was confirmed by comparison with synthetic cuscohygrine (chromatography).

Chromatographic analysis showed it to be present in the roots of the following species: *Atropa belladonna*, *Hyoscyamus niger*, *Datura stramonium*, *D. innoxia*, *D. ferox*, *D. metel*, *Scopolia lurida*, *S. sinensis*, *Physochlaine orientalis*, *P. physaloides* and *Mandragora officinalis*.

This discovery sheds a new light on the role of pyrrolidine derivatives in the biochemistry of the tropane alkaloids, which will be discussed elsewhere.

I wish to thank Prof. F. Galinovsky, University of Vienna, for providing a sample of synthetic cuscohygrine.

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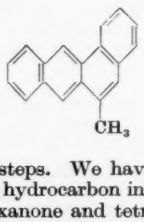
A Novel Synthesis of 4-Methyl-1 : 2-Benzanthracene

Of the various alkylbenzanthracenes, 4-methyl-1 : 2-benzanthracene aroused considerable interest through its pronounced carcinogenic activity[1]. The literature includes a few syntheses of this hydrocarbon[2], but these methods are laborious since they



involve numerous steps. We have now worked out a new route to this hydrocarbon in four steps starting from 2-allyl*cyclo*hexanone and tetralin, based on the method developed by Mukherji and co-workers[3] for the synthesis of polycyclic aromatic hydrocarbons.

2-Allyl*cyclo*hexanone was made to react with tetralin in the presence of anhydrous aluminium chloride at 0–5° C., and 2-(β-methyl-β-(6-tetralyl)-ethyl)-*cyclo*hexanone (boiling point 210–215°/6 mm.; η_D^{35} 1·5578) was obtained in 70 per cent yield. Reduction of this ketone with aluminium *iso*propoxide in *iso*propyl alcohol gave the corresponding carbinol (boiling point 190–195°/3 mm.; η_D^{35} 1·5585) in almost quantitative yield. This carbinol was cyclized with concentrated sulphuric acid (1·84) to the corresponding dodecahydro-1 : 2-benzanthracene derivative (boiling point 190–195°/6 mm.; η_D^{35} 1·5600), which was smoothly dehydrogenated with palladium-charcoal (30 per cent) at 300–320° C. for 4 hr. to give 4-methyl-1 : 2-benzanthracene which (purified by regeneration from its picrate) crystallized from alcohol in pale yellow needles (melting point 123–124° C.; lit. (ref. 2*a*) melting point 124–124·6° C.).

The picrate crystallized from alcohol as brown-red needles (melting point 148° C.; calc. for $C_{25}H_{17}N_3O_7$: N, 8·91; found: N, 8·68; lit. (ref. 2*a*) melting point 148–149° C.).

The hydrocarbon gave a trinitrobenzene derivative which crystallized from alcohol as red needles (melting point 163° C.; calc. for $C_{25}H_{17}N_3O_6$: N, 9·23; found: N, 9·03; lit. (ref. 2*a*) melting point 163–164° C.).

Details of this work will be published elsewhere. The microanalyses were carried out by Drs. G. Weiler and F. B. Strauss (Oxford).

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Significance of Metallic Transfer in Orthopædic Surgery

In an earlier communication[1] attention was directed to the transfer of metal which can occur between a screwdriver tip and a screw head during the operation of screwing, and the possible significance this might have in orthopædic surgery was discussed. It was demonstrated by a radioactive tracer method that, whenever a screw is inserted, small fragments of metal are plucked out of the driver and remain adhering to the screw head. It was suggested that, although the amount of metal transferred is very small (about 10–100 μgm.), the particles may form corrosion centres and cause metal ions to pass into the surrounding tissue. This may cause tissue reaction and interfere with normal physiology even in cases where no gross corrosion is observed.

In our earlier work, the presence of abnormally high concentrations of iron in the tissues surrounding buried metals was demonstrated by staining microtome sections of biopsy specimens to give the prussian blue reaction. Recently, biopsy samples of such tissue have been analysed spectroscopically for us by Dr. A. H. Gillieson, of the Atomic Energy Research Establishment, Harwell. The quantities found were compared with the normal concentration of these ions in tissue[2]. All the samples were taken from regions adjacent to stainless steel plates and nails which had been buried in the body for three to four months. None of the cases showed visual evidence of corrosion. The results show that the tissues adjacent to parts of the metal handled with tools during its insertion are abnormally rich in the ions of its constituents. Concentrations up to five times normal were found. The tissues near unhandled parts of the buried metal, however, had ionic concentration not significantly different from normal.

These results confirm quantitatively the picture suggested by examination of the stained microtome sections of tissue, and show clearly that considerable quantities of the ions of the so-called inert metal pass into the surrounding tissues, and that this dissolution is greatest from regions which have been handled with tools during the insertion of the metal.

The amount of metallic transfer depends on the relative hardness and the specific nature of the contacting surfaces[3]. The effect of the hardness of the tool has recently been investigated quantitatively.

Samples of medical drivers and screws have been treated to alter their hardnesses, and the amounts of transfer occurring with various combinations have been measured. The table shows the relative amounts of transfer observed. These figures should be regarded as approximate only, as the amount of transfer showed large variations. All the samples of orthopædic drivers and screws examined had hardnesses of about 150 and 380 V.H.N. respectively, and the transfer under these conditions has been taken as unity. Clearly, the transfer may be reduced appreciably by increasing the hardness of the drivers or softening the screws.

DEPENDENCE OF THE RELATIVE AMOUNT OF TRANSFER ON THE HARDNESSES OF DRIVERS AND SCREWS

	Steel driver, 150 V.H.N.	Steel driver, 360 V.H.N.
Steel screw, 380 V.H.N.	1	$\frac{1}{10}$
Steel screw, 133 V.H.N.	$\frac{1}{4}$	$\frac{1}{16}$

It does not necessarily follow, however, that the smallest electrolytic action will occur when a hard tool is used; although a hard tool will reduce the metallic transfer, it will cause increased mechanical deformation of the oxide layer on the screw and may thus affect the inertness of the metal. Further experiments would be necessary to determine the relative importance of these two factors.

These experiments again indicate that some attention should be given to the tools used in orthopædic surgery, as well as to the buried metal.

We wish to thank Dr. A. H. Gillieson, of the Analytical Laboratory at Harwell, for his aid in the analysis of the biopsy samples.

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A Modified Wedge Method for exciting Shear Modes in Isotropic Media

THE wedge method developed by Bhagavantam and Bhimasenachar[1] has been very useful in the determination of elastic constants of solids. But very often it is found to be difficult to excite and identify the shear modes for the transmission maxima, as they are very weak and are of the same order of intensity as the spurious frequencies of the wedge. However, it has been pointed out[2] that, if small thin specimens are used, shear modes could also be excited, although feebly, due to edge coupling. Recently[3], it has been reported that shear modes cannot be excited in rocks which are coarse-grained and heterogeneous in composition. The method presented here describes a simple modification of the wedge method for exciting and identifying easily only the shear modes in isotropic media and thus overcoming the difficulties inherent in the normal wedge method.

The experimental arrangement consists of the usual Debye–Sears equipment for observing diffraction due to transmission maxima of the section under investigation using an X-cut quartz wedge as a continuous-frequency source. The modification introduced is that the specimen under investigation is placed at an angle to the incident sound wavefront instead of in contact with the wedge as in the usual method. By keeping the plate at an angle, the component of the impinging force that contributes to the shear stress on the specimen will increase and hence the shear modes can be excited intensely. By adjusting this angle to be greater than the critical angle for total reflexion of longitudinal waves in the plate, only transmission maxima due to shear modes are observed with an intensity equal to that of the longitudinal modes for normal incidence. The frequencies at which transmission maxima are observed correspond to the fundamental or harmonic of the shear modes in the plate placed at the appropriate angle. The shear velocity V' in the specimen is determined by using Rayleigh's expression for the condition of maximum transmitted energy at oblique incidence, namely:

$$\sin^2\varphi = (V/V')^2 - (V/2d \,.\, n/\nu)^2,$$

where φ is the angle of incidence of the sound beam on the plate, V the velocity of sound in the liquid in the diffraction cell, d the thickness of plate, n the order and ν the frequency of observed transmission maxima.

Results thus obtained for the shear velocities in some common metals and rocks are given in the accompanying table along with the values obtained by some other methods. All the sections are placed at an inclination of 25°.

Specimen	d (mm.)	$\frac{\nu}{n}$ (Mc./sec.)	Shear velocity (m./sec.)	Velocities obtained by other methods
Aluminium	0·83	2·859	2,843	2,820 (ref. 4)
Brass	0·80	1·551	2,033	2,024 (ref. 2)
Granite	1·13	1·164	2,113	2,370 (ref. 5)
Syenite	1·08	1·414	2,315	2,754 ,,
Shale	0·97	1·463	2,217	2,270 ,,

The advantage of this method is that no difficulty is experienced in identifying shear modes, as they are excited very intensely and the longitudinal modes are eliminated. The accuracy of these determinations is the same as in the normal wedge method. However, the large breadth of resonance present, particularly in coarse-grained rock sections, may lead to slight inaccuracy. But where it is very difficult to excite shear modes at normal incidence, this method is definitely advantageous. The method is at present limited to isotropic media. Full details will be published elsewhere.

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Formation of Compact Pieces of Grey Tin

In a previous communication[1] the formation of compact pieces of grey tin was announced. A spectrophotometrical analysis of the material used indicated the presence of mercury, a metal which does not occur in natural tin. Consequently, the presence of mercury must be responsible for the behaviour of this specific material. This fact led to an investigation of the properties of tin–mercury alloys.

According to the literature[2], addition of more than 2 atomic per cent mercury forms a two-phase system, the phases being tetragonal and hexagonal, the composition of this latter being given as $HgSn_{12}$. At 8 atomic per cent mercury, the tetragonal phase disappears.

We prepared tin–mercury alloys, in the range 0·03–6 atomic per cent mercury, by melting in vacuum. X-ray photographs, taken after annealing, showed the presence of the hexagonal phase already in alloys with more than about 0·2 atomic per cent mercury, that is, at much lower mercury contents than given in ref. 2.

All amalgams showed at − 20° C. an increased rate of transition as compared with that of pure tin (Johnson-Matthey). Above 0·2 atomic per cent mercury the grey tin formed is compact. X-ray photographs showed that the tetragonal tin phase is transformed into the cubic grey modification, whereas the hexagonal phase is still present after the transition in the two-phase system. It might be suggested that the hexagonal phase acts as a matrix, holding the particles of the grey tin together; but microscopical studies have provided so far no evidence in favour of this suggestion.

The presence of a few tenths per cent of mercury increased also the rate of transition of other samples of tin, among them commercial grade tin and even samples of tin containing a small quantity of lead, for example, 0·03 per cent, or 0·1 per cent bismuth. This latter is the more remarkable as these two metals themselves decrease the rate of transition. In all these cases compact pieces of grey tin were formed. Pieces measuring several centimetres in length and about 0·5 cm. thick were obtained in this way.

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External Metasomatism associated with Serpentine

After finding in Turkey that many geosynclinal serpentines appear to be submarine lava flows[1], we re-examined in Ayrshire the only known exposure of an actual contact between the Ballantrae serpentine and associated spilites. The evidence is difficult to disentangle, but it proved beyond doubt that the serpentine is earlier than the particular spilite concerned[2], not vice versa as had previously been supposed. Full publication has been delayed. Here we only wish to emphasize that the spilite, though the later of the two rocks, is strikingly altered for a distance of some few inches in from the contact, and that it is penetrated by some minute veins of serpentinous material, some of which also clearly cut the serpentine itself. Away from the contact the spilite is an olive-green rock, dappled with very pale grey, or whitish, felspars. In its altered border-zone, which has an almost abrupt boundary, it turns reddish, sometimes purplish, with areas that are much paler; and its felspars are completely pseudomorphed by dark green translucent material that appears darker, instead of paler, than the matrix.

Under the microscope, the red coloration of the altered base is seen to be due to a close precipitation of iron ore powder. The paler areas are rich in leucoxene. The pseudomorphed felspars are replaced by some mineral of the chlorite-serpentine category, which also seems to furnish the main constituent of the base.

One important conclusion which we drew was that the parent peridotite of the serpentine still contained fresh olivine when the spilite came into contact with it, for serpentinization of olivine seems to us the only possible source of the magnesian solutions responsible for the alteration of the spilite. Analogies with the development of white trap and of spilite itself are sufficiently obvious. The interest of the occurrence has been greatly enhanced by two subsequent descriptions of almost identical alteration in France. Vuagnat[3] has described the phenomenon in a spilitic pillow–lava–agglomerate with fragmental serpentine matrix in the Montgenèvre district of the High Alps, 180 km. south-south-east of Geneva; and Vuagnat and Jaffé[4] in a "conglomerate", as they call it, containing many spilitic fragments in a "sorte de pâte de serpentine", 2 km. east-north-east of Gets in the Prealps, 40 km. east from Geneva. These authors are as clear as ourselves that the alteration in the spilitic material is due to interaction with magnesian solutions. As regards the origin of the serpentine of the matrix, they are non-committal. We are, however, assured that some of the fragments in the matrix of the Montgenèvre occurrence show the typical mesh-structure of normal serpentine along with the usual bastite plates.

The new work carried out at Geneva is backed by rock analyses. These confirm, what is self-evident, the metasomatic nature of the alteration of the spilitic material. They also demonstrate that the main mineral (or minerals) produced is aluminous, and therefore chlorite rather than serpentine.

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Measurement of the Refractive Index of Cytoplasmic Inclusions in Living Cells by the Interference Microscope

A method of measuring the refractive index of living cytoplasm by phase-contrast microscopy was recently developed by Dr. R. Barer and his associates[1,2]. This method consisted essentially of suspending cells in an isotonic protein medium of the same refractive index as the cytoplasm, which

then, by phase-contrast, appeared to match the background in brightness and consequently was almost invisible. This formed the starting-point for the present investigation. Phase-contrast cannot normally be employed for the refractometry of cytoplasmic inclusions, since the refractive index of the cytoplasm that surrounds them cannot be varied at will like that of the medium in which the cells are suspended. When the cytoplasm matches the suspension-medium in brightness, a cell-inclusion that appears brighter will generally have a lower refractive index than the cytoplasm, and conversely; but no accurate quantitative estimate can be made.

With the interference microscope, on the contrary, it is possible to measure the actual phase changes produced by objects, and it recently occurred to me that, by its aid, the technique developed by Dr. Barer and his associates might be extended so as to measure the refractive index of cytoplasmic inclusions.

For the present investigation the double-refracting interference microscope of Messrs. Charles Baker was used, and the cytoplasmic inclusion chosen for testing the technique was the spherical *Nebenkern* in the developing spermatid of *Locusta migratoria*. This body is formed during spermatogenesis by the aggregation of all the mitochondria, and has the advantage of being a relatively large, nearly spherical body, lying in an almost completely clear cytoplasm. Also, since it consists mainly of protein and lipoprotein, a fairly close approximation of its water and solid content can be arrived at by assuming a refraction increment (α) of 0·0018 provided that its refractive index can be determined[2-4].

To prepare a suspension-medium that would have exactly the same refractive index as the cytoplasm of the cell, cells were suspended in suitable saline media to which varying amounts of bovine plasma albumin were added. The analyser of the microscope was turned to give a red background with unfiltered light from a ribbon-filament lamp. It was found that when the suspension-medium had a refractive index of 1·3535, the cytoplasm of the spermatids showed exactly the same red colour, and therefore nearly disappeared. This suspension medium was therefore used throughout. (By this method, a variation in the refractive index of the cell cytoplasm of 0·0009, or approximately 0·5 per cent of solid, could be detected without any difficulty.)

The *Nebenkern* was shown by the Becke test to have a refractive index higher than that of the cytoplasm. Under the interference microscope, it naturally appeared in a different colour from the cytoplasm and suspension medium. The phase-shift that caused this difference was measured with light from the same source but filtered through an Ilford 807 filter. This gave a narrow spectrum with (measured) maximum intensity at about 542 mμ. The 2-mm. double-focus objective was used. The analyser was first turned so as to darken the suspension medium and cytoplasm as much as possible, and then the phase-change due to the *Nebenkern* was measured by turning the analyser until the centre of the *Nebenkern* had become as dark as possible. From the measurement of the angle of rotation, it was possible to obtain a value for phase-difference to a fiftieth of a wave-length (or more accurately than this).

The *Nebenkern* being approximately spherical, its maximum depth along the optical axis of the microscope can be taken as being the same as that at right-angles to the optical axis. It is probable that in no case was the error of this measurement greater than 0·4 μ.

The refractive index, n, of the *Nebenkern* was calculated from the formula:

$$n = \frac{\theta}{360} \times \frac{\lambda}{t} + m,$$

where θ is the phase-change due to the *Nebenkern*, expressed as an angle, λ the wave-length of the light used (taken as 542 mμ), t the thickness (diameter) of the *Nebenkern*, and m the refractive index of the cytoplasm and suspension medium (1·3535, equivalent to about 10·7 per cent of solid).

Table 1 shows the values for the refractive index of the *Nebenkern* derived from measurements of this body in twenty different cells. The mean figure is 1·376. This suggests that the concentration of protein and lipoprotein in this cytoplasmic inclusion is on the average about 23 per cent. Even in adjacent cells, *Nebenkerns* having the same diameter were sometimes found to give appreciably different phase-changes; and this could indeed be expected, since the mitochondria only gradually coalesce to form a single body. Part of the variation in the refractive index of the *Nebenkern* was thus due to variation in the material itself. It is difficult to assess the actual error of the technique. Error is more likely to arise from measurement of the diameter than from measurement of phase-change. With objects as large as the *Nebenkern* the measurement of refractive index is unlikely to have been wrong by more than ± 0·004, or 2 per cent of protein.

Table 1

Locust No.	Diameter of *Nebenkern* (μ)	Phase-change (retardation in degrees)	Refractive index	Approx. per cent solid (assuming $\alpha = 0{\cdot}0018$)
1	4·2	66	1·3771	24·0
1	4·2	78	1·3814	26·0
1	4·2	76	1·3807	26·0
2	4·2	60	1·3750	22·5
2	4·2	68	1·3778	24·0
1	4·7	68	1·3751	22·5
1	4·7	72	1·3764	23·5
2	4·7	72	1·3764	23·5
2	4·7	74	1·3770	24·0
2	4·7	66	1·3745	22·0
2	4·7	78	1·3783	24·5
2	4·7	76	1·3777	24·0
2	4·7	58	1·3720	21·0
2	4·7	64	1·3739	22·0
2	5·3	68	1·3730	21·5
2	5·3	70	1·3736	22·0
2	5·3	76	1·3753	23·0
2	5·3	70	1·3736	22·0
2	5·3	64	1·3719	21·0
2	5·3	72	1·3742	22·0

I wish to thank Dr. J. R. Baker for letting me work in his laboratory and for his advice; and Mr. F. H. Smith, of Messrs. Charles Baker (the inventor of the instrument), for a valuable discussion. I am also indebted to Dr. I. W. Selman, of the Department of Biological Sciences, Wye College, for leave to carry out this work at Oxford.

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Cytology of the Scrophulariaceae and Orobanchaceae

In a previous communication[1], the occurrence of prochromosomes and of size differentiation in the chromosomes of *Rhinanthus minor* Ehrh. were described. Further work has led to the conclusion that the small chromosomes are constant in occurrence and number in *Rhinanthus minor* Ehrh., and that the basic number for the genus *Rhinanthus* is probably $x = 11$. This is the same basic number as the related genus *Euphrasia*, which also possesses a prochromosomal resting nucleus. No evidence of any size differentiation in the chromosome complement of *Euphrasia* exists (P. Yeo, private communication). Other members of the *Rhinanthus minor* aggregate, including *R. borealis* (Sterneck) Marshall, and dwarf plants like *R. perrieri* Chabert (with fuscous spotted corollas) from Shetland, have been found to possess the chromosome number $2n = 22$. Fourteen large chromosomes and a number not yet determined of smaller chromosomes have been observed in *R. calcareus* Wilmott and *R. stenophyllus* (Schur.) Druce. Continental *R. major* Ehrh. has been found to possess chromosomes similar in number and size differentiation to those of the *R. minor* aggregate shown in Fig. 1. Fagerlind[2], in 1936, described the eight smaller chromosomes in the diploid complement of *Alectorolopus* (*Rhinanthus*) *major*, and gave the chromosome number as $n = 11$ for this species.

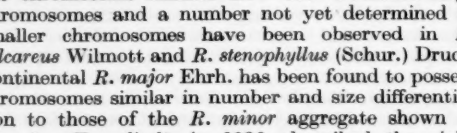

Fig. 1. Root tip chromosomes of *R. minor* Ehrh. at metaphase, showing size differentiation. × 1,500

Melampyrum cristatum L., a species morphologically related to *Rhinanthus* and *Euphrasia* (and like them a hemiparasite), has been examined cytologically. The resting nucleus of this species contains no prochromosomes, the chromatic material being contained in numerous small chromocentres. The diploid number for *M. cristatum* L. is $2n = 18$, which agrees with counts for other members of this genus. The chromosomes at meiosis appear to be of approximately uniform size.

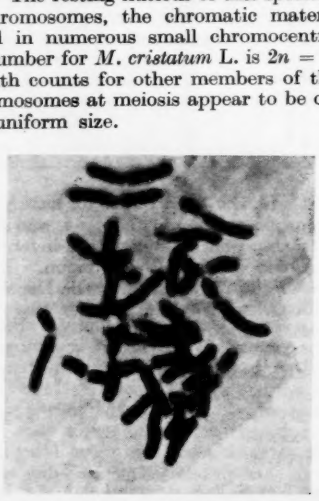

Fig. 2. Mitotic metaphase in the sporogenous tissue of an anther of *Orobanche purpurea* Jacq. The chromosomes are large and the centromeres are distinctly visible at this stage. × 1,500

Note added October 7. *Parentucellia viscosa* (L.) Caruel, formerly known as *Bartsia viscosa* L., another hemiparasitic member of the Scrophulariaceae, has been found to possess $2n = 48$ chromosomes, that is, it has the same basic number $x = 12$ as *Bartsia alpina* L., which is recorded[3] as possessing $2n = 24$ chromosomes.

Species of *Orobanche* in Britain shown to possess $2n = 38$ chromosomes include *O. minor* Sm., *O. maritima* Pugsl., *O. elatior* Sutton., *O. reticulata* Wallr., *O. picridis* F. Schultz, *O. hederae* Duby, *O. rapum-genistae* Thuill and *O. caryophyllacea* Sm. The above species of *Orobanche* are members of the subgenus *Osproleon* Wallr. *O. purpurea* Jacq. from Norfolk has been shown to possess the number $2n = 24$, counts having been obtained in both mitotic (Fig. 2) and meiotic preparations. *O. purpurea* Jacq. has been placed in the subgenus *Trionychon* Wallr., members of which differ from the subgenus *Osproleon* in their possession of two prophylls in addition to each bract. It has now been shown that there are cytological as well as morphological grounds for this division of the genus *Orobanche*.

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Systematic Position of the Genus *Oscillospira*

The bacterial nature of the genus *Oscillospira* has been the subject of some dispute; Delaporte[1] considered the group to be Myxophyceae adapted to a parasitic mode of life, which had lost some algal characteristics, and Pringsheim[2] considered it truly bacterial. It has recently been shown to possess typical eubacterial nuclear structures[3]. Pringsheim[2] reported that Robinow had demonstrated flagella, but these structures have not previously been illustrated. It has also proved difficult to demonstrate the existence of true cross-walls between the component cells. These characters constitute one of the most important cytological distinctions between bacteria and Myxophyceae[4].

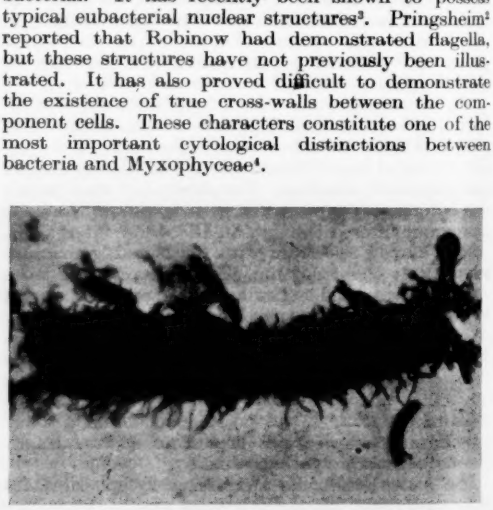

Fig. 1. *Oscillospira guilliermondii*. Kirkpatrick's flagella stain. Preparation made from guinea pig cæcal contents, with other micro-organisms adjacent. × 650

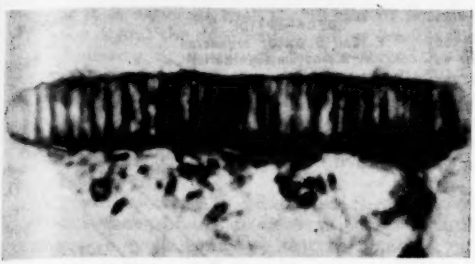

Fig. 2. *O. guilliermondii*. Trichome, consisting of numerous disk-like cells. Cross-walls stained by Hale's method. × 1,000

Both flagella and cross-walls of a distinctly bacterial character have now been demonstrated in *Oscillospira guilliermondii* in the cæcal contents of guinea pigs. Fig. 1 shows a trichome with numerous peritrichous flagella, stained by Kirkpatrick's technique[5]. Fig. 2 shows a similar trichome, in which the cross-walls have been demonstrated by Hale's phosphomolybdic acid–methyl green technique[6].

The demonstration of these structures establishes the eubacterial nature of *Oscillospira* beyond question, despite its relatively enormous size.

I wish to acknowledge the assistance of Miss C. M. F. Hale, who made the preparation shown in Fig. 2.

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Antiœstrogenic Potencies of Various Progesterone Derivatives with Oxidation at C_{11}

Evidence has been given that certain anti-œstrogenic potencies of progesterone such as the anti-fibromatogenic, antihysterotrophic and antiluteinizing ones are diminished by oxidation at C_{21}, C_{11} and C_{17}. Thus, deoxycorticosterone (C_{21}—OH) is less anti-fibromatogenic and less antiluteinizing than pro-gesterone; dehydrocorticosterone, or substance *A* of Kendall (C_{11}=O), is less antifibromatogenic than deoxycorticosterone; 17-hydroxy-deoxycorticoster-one, or substance *S* of Reichstein, is neither anti-fibromatogenic nor antihysterotrophic[1–4]. More recently, the workers of the Upjohn Co. have obtained various derivatives of progesterone by oxidation at C_{11} such as 11-keto-progesterone, 11-α-hydroxyprogesterone and 11-β-hydroxyprogesterone; these compounds, when tested in various ways, have been found to be only about 3–10 per cent as pro-gestational as progesterone, or even less than that[5,6]. Our former knowledge of the diminution of the anti-fibromatogenic potency through oxidation at C_{11} has been obtained only in comparative work with deoxycorticosterone and dehydrocorticosterone[3]; this is why we thought it convenient to test the three new C_{11}-derivatives of progesterone mentioned as to their antifibromatogenic and antihysterotrophic potencies.

11-Ketoprogesterone. All animals had a pellet of œstradiol subcutaneously implanted. The specific steroid to be tested was administered by absorption from one or two pellets containing 40 and 80 per cent of the substance mixed with 60 or 20 per cent of cholesterol; the absorption-rate of pure 11-keto-progesterone was about three times that of pro-gesterone. There was an antifibromatogenic and antihysterotrophic action in all groups as seen when compared with substances VIII–X (see table); but potency was much smaller than with progesterone (IV, V).

11-β-Hydroxyprogesterone. Pellets containing 40 and 80 per cent of this substance were used; ab-sorption-rate of the pure substance was almost twice that of progesterone. Activity was very similar to that of 11-keto-progesterone.

11-α-Hydroxyprogesterone. The absorption-rate of the pure compound was three times that of pro-gesterone; pellets containing 40 and 80 per cent of the substance were used. There was no anti-fibromatogenic potency; the fibrous tumoral effect was similar to that of animals receiving œstradiol only. There was a slight antihysterotrophic action. The difference between the two 11-hydroxy-stereo-isomers is very remarkable. It may be remembered that a similar situation was found when studying the 17-hydroxy-corticoids: they are all 17-α and lack antifibromatogenic and antihysterotrophic potency[2,3]. The difference between testosterone-17-β and testosterone-17-α (or *cis*testosterone) also is remarkable: the latter showed no antifibromatogenic action with quantities three times those of testo-sterone[1,2].

Fig. 1 summarizes the comparative results obtained by various workers and also our group in experi-ments in which steroids with oxidation at C_{21}, C_{11} and C_{17} have been used. Not all the luteoid potencies have been studied so far in a satisfactory manner; a comparative study of the antiluteinizing potency of the C_{11} derivatives of progesterone is in progress.

Experiments in 77 Castrated Female Guinea Pigs receiving during Three Months Œstradiol and Progesterone (P), or 11-Keto-Progesterone (11-Keto-P), or 11-β-Hydroxy-Progesterone (11-β-OH-P), or 11-α-OH-Progesterone (11-α-OH-P)

	Specific steroid	No. of animals	Œstrad. per day (μgm.)	Spec. steroid per day (μgm.)	Fibrous tumoral effect*	Coeff. Q_{3-5}*	Ut. weight (gm.)	Specific steroid No. of pell.; percentage in mixture
I	11-keto-P	10	52	75 (62–85)	2·5 (1·5–5·5)	0·3	2·0 (1·1–4·2)	2; 40 per cent
II	11-keto-P	6	41	277 (253–318)	2·4 (1·5–5·5)	0·5	2·1 (0·7–4·5)	1; 80 ,,
III	11-keto-P	7	49	577 (522–626)	1·7 (1–3)	0·1	1·4 (0·7–2·9)	2; 80 ,,
IV	P	5	50	92 (83–108)	1·0 (1–1)	0	1·5 (1–2·3)	1/4; pure
V	P	10	47	200 (126–306)	1·3 (1–1·5)	0	1·4 (0·5–2·2)	1/2 and 1; pure
VI	11-β-OH-P	9	37	78 (60–96)	2·7 (1·5–7)	0·7	1·7 (1·1–2·3)	4; 40 per cent
VII	11-β-OH-P	6	45	490 (360–578)	2·2 (1–4·5)	0·2	1·9 (1·4–2·5)	2; 80 ,,
VIII	11-α-OH-P	14	55	74 (55–127)	4·6 (1·5–9·5)	1·2	5·8 (3·1–9·6)	4; 40 ,,
IX	11-α-OH-P	4	44	270 (250–293)	5·5 (2·5–9)	1·5	3·7 (3·1–4·2)	1; 80 ,,
X	11-α-OH-P	6	47	469 (424–497)	5·0 (3–8)	1·5	2·8 (1·7–3·6)	2; 80 ,,

* Lipschutz, A. and Maass, M., *Cancer Research*, **4**, 18 (1944).

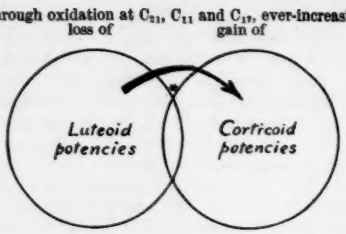

Fig. 1. Luteoid potencies: (1) progestational; (2) anticestrogenic: (*a*) antifibromatogenic; (*b*) antihysterotrophic; (*c*) antiluteinizing

Thanks are due to Drs. A. C. Ott and W. W. Byrnes, of the Upjohn Company, Kalamazoo, Mich., for a liberal supply of the steroid compounds and for information about some of their luteoid potencies.

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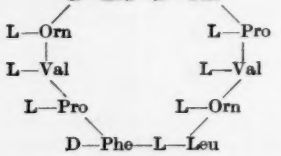
Gramicidin *S*: Relationship of Cyclic Structure to Antibiotic Activity

Gramicidin *S* is a polypeptide antibiotic elaborated by a strain of *Bacillus brevis*[1]. Its postulated structure, well substantiated by experimental results[2], is that of a cyclic decapeptide of the following nature[3]:



The peptide contains a five amino-acid sequence which appears twice. It also contains an amino-acid of the D ('unnatural') configuration, D-phenylalanine, and an amino-acid rarely encountered in naturally occurring peptide structures, L-ornithine.

Harris and Work[4], in order to investigate the structural characteristics of this peptide which might be responsible for its antibacterial activity, synthesized several model non-cyclic peptides and derivatives, including three pentapeptide derivatives having the proper sequence. In one case L-phenylalanine replaced the D-isomer. None of these compounds was found to have more than negligible antibacterial activity. It was concluded that the activity does not seem to be directly related to the presence of D-phenylalanine or L-ornithine but that "the biological activity of gramicidin *S* is intimately related to its cyclic structure". This conclusion is repeated in a review by Bricas and Fromageot[5].

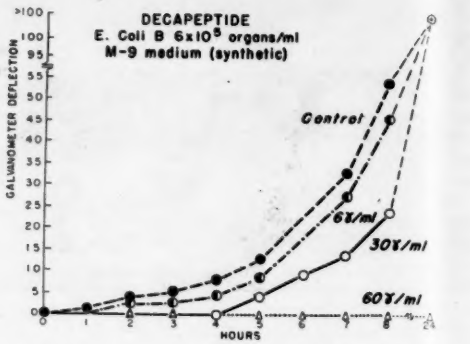


Fig. 1

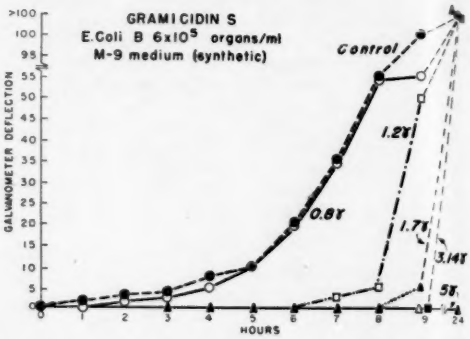


Fig. 2

Erlanger, Sachs and Brand[6] have synthesized, among other related peptides, the straight-chain decapeptides: H. Val – *p*. Tos. Orn – Leu – Phe – Pro – Val – *p*. Tos. Orn – Leu – Phe – Pro. OMe. HCl (L–L–L–D–L)$_2$ and H. Val – Orn – Leu – Phe – Pro – Val – Orn – Leu – Phe – Pro. OH. 3HCl (L–L–L–D–L)$_2$. The latter is identical in structure and sequence with gramicidin *S* except that it is acyclic. The former is, in addition, substituted with a *p*-toluenesulphonyl group on the δ-amino group of each ornithine. The unsubstituted peptide has been found to be biologically active against *Staph. aureus* and *E. coli*. The tosylated compound and other smaller peptides[6] including the pentapeptide H. Val – Orn – Leu – Phe – Pro. OH. 2HCl (L–L–L–D–L) are inactive.

Figs. 1 and 2 compare the antibacterial activity of the decapeptide with that of gramicidin *S* against *E. coli*. In a synthetic medium with an inoculum of 600,000 organisms/ml., the peptide is bactericidal in a concentration of 60 γ/ml. Under identical conditions, 5 γ/ml. of gramicidin *S* gave a similar effect. At lower concentrations both substances increase the length of the lag period. Preliminary work indicates that the surviving organisms possess enzymes capable of destroying or neutralizing the compound. This enzymatic capacity is lost after a single transfer of the organism in fresh medium.

Similar findings were obtained with *Staph. aureus*, the bactericidal concentrations being 3 γ/ml. for gramicidin *S* and 120 γ/ml. for the decapeptide, respectively.

Unless it is assumed that the modes of action of gramicidin *S* and the decapeptide differ, despite their great similarity in structure, one is forced to the conclusion that the cyclic structure is not directly or intimately related to activity. The lack of activity of the pentapeptide rules out the specific influence of D-phenylalanine or L-ornithine, although these amino-acids may be essential to an overall structure possessing activity.

The greater activity of gramicidin *S* may be due to a lesser susceptibility to destruction by bacterial enzymes. A cyclic structure can be attacked only by endopeptidases, and the presence of D-phenylalanine and L-ornithine would materially decrease the number of enzymes capable of hydrolysing this compound. On the other hand, the straight-chain compound is also susceptible to amino- and carboxypeptidases.

Work is continuing with the aim of correlating antibacterial activity more closely with molecular structure.

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[3] Abbreviations are discussed in ref. 6. In general, the first three letters are used to designate the amino-acid residue, for example, Leu = leucyl residue.
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Intracellular Sites of Metabolism of 3 : 4 Benzpyrene in Mouse Liver

Previous work[1] has shown that after intravenous injection of colloidal 3 : 4 benzpyrene the bulk of the carcinogen is held in the liver. Excretion takes place over approximately twenty-four hours, the hydrocarbon having undergone metabolic oxidation to one or other of two compounds labelled BpX_1 or BpX_2. These are oxidation products and have been characterized by physical methods and analogy with known derivatives of other polycyclic hydrocarbons as being : 8(OR_1) − 9(OH) − 8,9 dihydro 3 : 4 benzpyrene and 8(OR_1) − 9(OR_2) − 8,9 dihydro benzpyrene respectively. The groups R_1 and R_2 are, at present, unidentified radicals. It has also been found[1,2] that during metabolic oxidation the products derived from 3 : 4 benzpyrene are firmly bound within the tissues where they are formed.

Working upon these facts, we have endeavoured to trace the sites at which oxidation occurs. Groups of 6–8 mice have been injected intravenously with 0·05 mgm. of benzpyrene as a colloid in water. At intervals up to 24 hr. they have been killed, the livers removed, homogenized in Tyrode solution and separated centrifugally into nuclei, mitochondria, microsomes and supernatant. Each fraction has been extracted for benzpyrene metabolites, using the method devised by Weigert[3]. Final purification has been by column chromatography on silica. Estimation of the metabolites was by absorption spectra over the range 340–430 mμ and confirmed by the fluorescence spectra.

Under these conditions the metabolite BpX_2 has been found in all four fractions at time intervals of 2½, 4, 8, 12, 17 and 24 hr. after injection of the hydrocarbon. Over the same time intervals BpX_1 was only found in the supernatant fraction. Unchanged benzpyrene was regularly found in the nuclear, mitochondria and microsome fractions, but could only be detected in trace amounts in the supernatant fractions.

Since it is possible to argue that the metabolites were adsorbed to the different fractions during the homogenization or centrifuging, a further series of experiments was undertaken. Batches of untreated liver were fractionated as previously and each fraction was then suspended in Tyrode solution containing colloidal benzpyrene. They were placed in the incubator at 37° C. in total darkness, this latter condition being imposed by the necessity for avoiding any photosensitizing action by the hydrocarbon. After periods of up to 2½ hr. incubation, they were extracted as previously and examined for metabolites. BpX_2 was obtained from all four fractions and BpX_1 from the supernatant only. These results show that metabolism must occur within the fractions themselves.

The penetration of benzpyrene into all parts of the cell and its engagement in chemical activity at various sites closely parallels the findings of Danielli[4] and his co-workers with regard to nitrogen mustard. These workers concluded that the action of this compound, which is also carcinogenic, is 'diffuse', and it now appears that benzpyrene behaves in similar fashion.

A detailed account of this work will be published elsewhere.

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Northwood, Middlesex.
July 14.

[1] Weigert, F., and Mottram, J. C., *Cancer Res.*, **6**, 97 (1946).
[2] Weigert, F., Calcutt, G., and Powell, A. K., *Brit. J. Cancer*, **1**, 405 (1947).
[3] Weigert, F., *Cancer Res.*, **8**, 169 (1948).
[4] Danielli, J. F., *Nature*, **170**, 863 (1952).

Nitrogen Fixation by Soil Yeasts

Since the discovery by Starkey and De[1] of the soil bacterium *Azotobacter indicum*, which is capable of fixing atmospheric nitrogen under acid conditions, many unsuccessful attempts have been made to isolate this species from acid soils in western Europe. In one such attempt, preliminary experiments had suggested that the soil of a *Betula – Calluna* heath in Kent contained organisms able to fix atmospheric nitrogen, but attempts to isolate these organisms by the 'still culture' enrichment method failed. This method is not suited to the isolation of organisms present in acid soil in very small numbers : for such organisms continuous perfusion of a large volume of soil with selective media is a far superior method.

Columns of heath soil (*p*H 4·5 approx.) taken from the *A*1 horizon of the podsol beneath *Calluna vulgaris* were continuously perfused with media containing a carbon source but no source of fixed nitrogen. On different occasions mannitol, benzoate, various esters and alcohols were used. The perfusate and the soil were sampled at intervals for micro-organisms by

streaking on a medium of composition similar to that of the perfusate. Various fungi and bacteria appeared on the plates, particularly on the mannitol plates; on individual transfer to new medium in an atmosphere free from ammonia all failed to grow, with the exception of two yeasts from the mannitol perfusate, which grew slowly but steadily. These two yeasts, one (non-sporing) resembling a *Saccharomyces* and one a pink *Rhodotorula*, were inoculated into nitrogen-free mannitol-phosphate liquid medium and periodically aerated with ammonia-free air; growth was steady and after fourteen days a considerable deposit of yeast had formed. Assessment of nitrogen-content by the micro-Kjeldahl method showed a high gain compared with controls, a gain well above the errors of estimation and corresponding to a rate of fixation (on different occasions) of up to 4 mgm. nitrogen per gm. of mannitol originally available. An interesting feature of these nitrogen-starved yeasts was the presence of large oil globules in the cells and a very sparse retention of dye when stained by Gram's method.

In the course of further extensive investigations by Chayen, using perfusion enrichment followed by isolation on nitrogen-free media, a large number of yeasts have been isolated from the *A*1 horizon of the same *Calluna* heath soil. A representative sample of these was tested for ability to grow in aerated nitrogen-free media under conditions ensuring the rigid exclusion of atmospheric ammonia; some twenty isolates grew under these conditions. Tests for increase in fixed nitrogen by micro-Kjeldahl estimation on the whole culture gave significant gains; for one *Rhodotorula* these gains corresponded to the fixation of 1–3 mgm. of atmospheric nitrogen per gm. of glucose available. Further tests on this *Rhodotorula* and on another isolate, using an isotopic nitrogen technique, are described in the following communication by Roberts and Wilson.

In addition to the nitrogen-fixing yeasts, two quite distinct strains of nitrogen-fixing bacteria of the genus *Azotobacter* have been isolated using mannitol as the perfusate. These bacteria are distinct from previously described 'species' of *Azotobacter*, including *A. indicum*. This work, with descriptions of the organisms and their growth under differing experimental conditions, will be published in detail elsewhere.

George Metcalfe
Sonja Chayen

Department of Botany,
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University of London,
London, W.C.2.
July 22.

[1] Starkey, R. L., and De, P. K., *Soil Sci.*, **47**, 329 (1939).

A method has been developed in this laboratory whereby the rate-constant of the nitrogen-fixation process is obtained solely from isotope abundance measurements[1]. At the suggestion of Metcalfe and Chayen, we have applied this method to certain soil yeasts isolated by Chayen and have confirmed their observations that these organisms are capable of taking up molecular nitrogen (see preceding communication).

Cultures of two yeasts, *Rhodotorula* (I) and *Saccharomyces* (II), were studied; they were thought to have nitrogen-fixing capacities 1/10 and 1/50, respectively, of that of *Azotobacter*. An atmosphere consisting of oxygen, argon and nitrogen, the latter containing 32·0 atom per cent excess of nitrogen-15, was circulated through duplicate cultures of the yeasts in a medium free from combined nitrogen. The cells were actively budding immediately prior to the experiment. At the end of four hours, the cells were harvested, subjected to Kjeldahl digestion, and the ammonia produced converted to nitrogen by reaction with sodium hypobromite. The isotope abundance in these samples was determined by means of a mass spectrometer; the abundance of nitrogen-15 in ordinary air was 0·41 per cent.

Culture	Atmosphere			Percentage nitrogen-15 in cell nitrogen	
	p_{N_2}	p_{O_2}	p_A	(i)	(ii)
I	0·17	0·40	0·30	1·38	1·41
II	0·04	0·40	0·40	0·45	0·48

These results show clearly that the yeasts, especially I, had taken up molecular nitrogen. Moreover, the extent to which fixation occurred was consistent with expectations based on total nitrogen determinations.

We are indebted to the Royal Society for a grant with which the isotopic nitrogen used in this experiment was purchased, and to Dr. G. A. Meek, who performed the isotope analyses. One of us (T. G. G. W.) is indebted to the Middlesex Education Committee, and to Glaxo, Ltd., for financial assistance.

E. R. Roberts
T. G. G. Wilson

Dept. of Inorganic and Physical Chemistry,
Imperial College of Science and Technology,
London, S.W.7.
July 22.

[1] Pethica, B. A., Winter, E. R. S., and Roberts, E. R., *Biochim. et Biophys. Acta*, **14**, 85 (1954).

Acceleration of Flowering in Non-vernalized Chrysanthemums by the Removal of Apical Sections of the Stem

It has been shown that plants of *Chrysanthemum morifolium* 'Sunbeam' (incorrectly termed 'Indian Summer'), raised from basal cuttings taken from parent plants grown and flowered at high temperatures, require a period of low temperature or vernalization in order that normal stem elongation and rapid flowering may occur. Without such a period of low temperature these plants grown in high temperature conditions (> 60° F.) fail to elongate normally and are considerably delayed in flowering[1].

If an apical section of the stem is removed, however, the two or three lateral shoots thus induced to develop do not show the rosette habit and diageotropic growth characteristic of the main axis, and flower rapidly (see Fig. 1).

Non-vernalized plants of 'Sunbeam', from cuttings taken on December 30, 1953, were grown at temperatures above 60° F. in natural day-length conditions until June 15, 1954. On this date the plants, which had laid down approximately fifty leaves, were cut back to twenty-five, thirty-five or forty-five leaves, or left intact, and were placed immediately in short-day (10-hour) conditions. The laterals, which developed as a result of removal of the apical sections, elongated normally and rapidly produced macroscopically visible buds. The main axis of the intact

Fig. 1. Non-vernalized plants of 'Sunbeam' after seven weeks of short-day conditions. Left, intact plant; right, plant cut back to 25 leaves

plants continued to show rosetting and diageotropic growth, and flowered only after a considerable delay. The acceleration of flowering is shown by the decreased number of weeks to bud (from the date of commencement of the short-day treatment) of the distal lateral of the cut-back plants compared with the terminal bud of the main axis of the intact plants (Table 1). The number of leaves laid down on the terminal laterals of the cut-back plants and the approximate number of leaves laid down on the main axis of the intact plants, from the commencement of the short-day treatment to flowering, is also shown in Table 1. The increase in internode elongation of the lateral shoots is also apparent.

Removal of apical sections from non-vernalized plants of 'Sunbeam' resulted, therefore, in accelerated flowering and normal elongation of the internodes on the distal lateral shoots when the plants were grown in short-day, high-temperature conditions, and apparently removed the source of some substance normally inhibiting flowering and internode elongation in such non-vernalized plants. The production of a single inhibiting substance by the vegetative apex of non-vernalized plants preventing both internode elongation and flowering would appear to be too simple a hypothesis; but it seems likely from these results that, in this variety, some inhibiting substance is produced by the apex of the main axis which is not produced, or produced to a lesser degree, by the apices of the lateral shoots which develop when apical dominance is removed.

Another variety, 'President', which entirely fails to flower when not vernalized and shows extreme rosetting[2], did not show the same response to removal of an apical section of the stem. A slight increase in elongation of the internodes of the lateral shoots was observed initially, but afterwards the rosetted habit was resumed and the lateral shoots failed to flower except in two instances (16·5 per cent of the plants). In no case did plants flower on the main axis. In this variety, which shows a more extreme type of behaviour (rosetting and failure to flower) in the non-vernalized condition, the inhibiting effect is apparently re-imposed in the lateral shoots when the apical sections are removed in short-day conditions. Evidence from a further experiment, as yet incomplete, suggests that if a sufficient number of long-day cycles is given after decapitation, the inhibition is not completely re-imposed and some lateral shoots are able to elongate, and will afterwards flower when placed in short-day conditions. These experiments will be reported in more detail elsewhere.

Table 1. Effect of Removal of Apical Sections of the Stem on Flowering and Internode Elongation in *Chrysanthemum morifolium* 'Sunbeam'

	Intact plants*	Cut back* to leaf No. 25	35	45	L.S.D. at $P=0.05$
No. of weeks to bud from commencement of short day	12·00	8·25	7·00	6·25	2·64
No. of leaves formed from commencement of short day to flowering	36·00	15·75	15·75	13·75	10·64
Mean internode length (cm.)	0·60	1·13	1·99	1·66	0·52

* Figures for intact plants refer to the main axis. Figures for cut-back plants refer to the distal lateral only.

D. Vince
D. T. Mason

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Sept. 28.

[1] Schwabe, W. W., *J. Exp. Bot.*, 1, 329 (1950).
[2] Vince, D., *J. Hort. Sci.* (in the press).

Occurrence of *Haplosporangium parvum* in the Lungs of the Mole (*Talpa europaea*)

During the spring of 1947 and again in 1953, large numbers of dead and dying moles were found on the Berkshire Downs, and examination (by A. McD.) of many of these and of others trapped at the same time showed evidence of pneumonia. Lesions of a granulomatous nature, varying greatly in size, were scattered throughout the lungs, often protruding above the surface, and histological examination showed these reactions to be invariably associated with the presence of a central thick-walled spherule, 100–200 microns in diameter (Fig. 1). Material from these animals was examined in the course of a survey of animal mycoses sponsored by the Agricultural Research Council, and the spherules were recognized as bearing a close resemblance to those found in *Haplosporangium parvum* Emmons and Ashburn infection in small mammals, hitherto only reported from North America by Emmons and Ashburn[1] and Dowding[2].

Fresh material from the Berkshire epizootic not being available, a number of moles trapped in the Exeter district were examined (by P. K. C. A.) during May 1954, through the kind co-operation of the Devon Agricultural Executive Committee, and, from lesions similar to those described above, typical *Haplosporangium parvum* was isolated in culture. Of thirty-one apparently healthy moles from Devon and

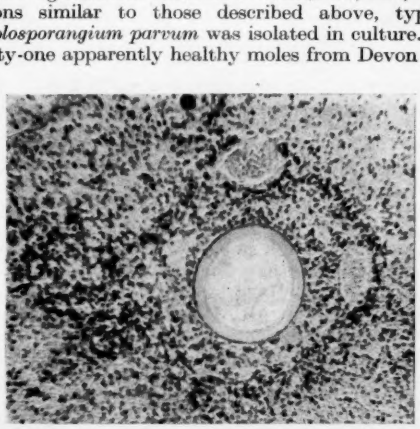

Fig. 1. Section of mole lung showing thick-walled spherule. × 100

Berkshire, twenty-five had spherules present in varying numbers in the lungs. The isolate has the 'granular type' of colony described by Carmichael[3], forms conidia 3–4 microns in diameter and, with a spherule diameter of 100–390 microns, agrees well with the northern strain of the fungus (Dowding[2]). This appears to be both a new host species and the first record for Europe, although we believe *H. parvum* is now known in several other parts of the world.

The role, if any, of *Haplosporangium parvum* in the periodic fluctuations in the mole population of Britain, which occur about every six years (cf. Elton[4]), is undoubtedly complicated by the additional presence in those lungs we have examined of a nematode (species not yet identified), and at least one pathogenic aerobic actinomycete (*Nocardia* sp.). The significance of these organisms, especially in apparently healthy animals, is in no way understood.

Herbarium specimens and cultures have been deposited at the Mycological Reference Laboratory, London School of Hygiene and Tropical Medicine, and at the National Microbiological Institute, Bethesda, Maryland.

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Agricultural Research Council
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University College,
Exeter.

[1] Emmons, C. W., and Ashburn, L. L., *Pub. Health Rep. Wash.*, **57**, 1715 (1942).
[2] Dowding, E. S., *Can. J. Res.*, **25**, 195 (1947).
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[4] Elton, C., *J. Hygiene*, **31**, 435 (1931).

Transmigration of Unborn Mice

The evidence on transuterine ('internal') migration, that is, the passage of ova down the oviduct and uterine horn of one side into the uterine horn of the other side, has recently been summarized by Boyd and Hamilton[1]. They found no record of the phenomenon in any rodent on which relevant observations had been made (rabbit, guinea pig, rat and field vole). Young[2] has, however, since demonstrated its occurrence in the rat.

In the course of fertilized egg transfers, we have found that transuterine migration of fertilized eggs can also occur in mice. Fertilized eggs were collected from immature albino females, $2\frac{1}{2}$ or $3\frac{1}{2}$ days after they had been artificially induced to ovulate[3] and mated to albino males. The eggs were injected by the method of Fekete and Little[4] into the upper part of the left uterine horn of adult females mated $2\frac{1}{2}$ or $3\frac{1}{2}$ days previously. Shortly before term, the recipients were killed and the contents of their uteri examined. Since the recipients and their mates were homozygous for full colour, embryos derived from transferred eggs could be distinguished from the native embryos by eye colour.

Of twelve embryos derived so far from eggs transferred $2\frac{1}{2}$ days after ovulation, one was found implanted in the right (uninjected) horn. Of thirty-four derived from eggs transferred at the $3\frac{1}{2}$-day stage, three were found in the right horn.

It is possible that the phenomenon does not occur in normal pregnancies, and that these transmigrations were assisted by the pressure of the fluid medium in which the eggs were injected. Conclusive evidence would be provided by the injection of unfertilized eggs into the *bursa ovarii* and their fertilization in the host animal. By the time that such eggs arrived in the uterus, the hydrostatic condition of the two sides of the reproductive tract would surely have become equalized. An experiment of the required type was recently performed by Runner and Palm[3]. Of twenty embryos derived from transferred eggs, none was found implanted on the uninjected side. But the numbers involved are small and there is no significant discrepancy between this result and our own.

We are in receipt of a research grant from the Agricultural Research Council, which we gratefully acknowledge.

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July 26.

[1] Boyd, J. D., and Hamilton, W. J., Chapter 14 of Marshall's "Physiology of Reproduction", **2**, 3rd edit. (Longmans, 1952).
[2] Young, A., *Proc. Roy. Soc. Edin.*, B, **65**, 106 (1953).
[3] Runner, M. N., and Palm, J., *J. Exp. Zool.*, **124**, 303 (1953).
[4] Fekete, E., and Little, C. C., *Cancer Res.*, **2**, 525 (1942).

Morphological Basis of Quality in Tea

The possibility of distinguishing morphological characteristics that will help in the recognition of strains of tea capable of producing enhanced quality in the manufactured product is of importance to tea producers and research workers in regions outside Assam. The pioneer work of Dr. W. Wight and Mr. P. K. Barua[1] is consequently of particular interest.

While recognizing that such work is only in a preliminary stage, there appears to be some confusion in the interpretation of the data between the concepts of the statistical significance and importance respectively to be attached to the values of the correlation coefficients under consideration.

The high significance of the correlation between pigmented plants and hairy plants indicates that the value of 0·493 has not arisen fortuitously; but it gives no indication of the importance of the value itself as a measure of association. The correlation coefficient is not equally sensitive throughout its range to differences in degree of association, relatively small variations in value in the high range being of more importance than much greater ones at the other end of the scale.

A more sensitive estimate of predictability can be derived from the function $1 - \sqrt{1 - r^2}$. For a correlation coefficient of 0·493 the predictability index is 0·13. The analogous figure for the correlation coefficient of 0·76 between taster's valuation and leaf hairiness is 0·35.

While the possibility of concentrating 35 per cent of the total variation in a common association with a single morphological characteristic is suggestive, it scarcely merits the statement that "hair can be taken as a reliable index of quality".

T. Eden
Tea Research Institute of East Africa,
Kenya.
June 1.

[1] *Nature*, **173**, 630 (1954).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 1

BRITISH OCCUPATIONAL HYGIENE SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Third Conference—"Radiation Hazards in Industry".

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. Dorothy Emmet: "Role, Function and Vocation". (Further Lectures on November 8 and 15.)*

UNIVERSITY OF LONDON (in the Assembly Hall, Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Prof. Rex Knight: "Children's Needs and Interests—Contemporary Psychological Theories of Motivation". (From a series of seven lectures on "The Bearings of Recent Advances in Psychology on Educational Problems".)*

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the FOOD AND MICROBIOLOGY GROUPS, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. A. Pollard: "Newer Aspects of Cider Research"; Mr. F. W. Beech and Mr. J. G. Carr: "Problems Involved in the Isolation and Classification of Cider Micro-organisms".

Tuesday, November 2

PHYSICAL SOCIETY, COLOUR GROUP (at the Institute of Ophthalmology, Judd Street, London, W.C.1), at 3.30 p.m.—Mr. H. G. Jenkins and Mr. E. E. Miles: "The Use of Phosphors as Light Sources"; Mr. T. Thorne Baker: "Daylight Fluorescence—Its Nature and Applications".

ARTHUR STANLEY EDDINGTON MEMORIAL TRUST (at the Arts' School Lecture Theatre, Bene't Street, Cambridge), at 5 p.m.—Prof. H. Dingle: "The Sources of Eddington's Philosophy" (1954 Eddington Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Boreholes—Instrumentation for Measurements at Depth".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. David M. Watson: Presidential Address.

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. H. S. Rainbow: "Design of Small Jet Engines".

Tuesday, November 2—Thursday, November 4

BRITISH WEED CONTROL COUNCIL (in conjunction with the Ministry of Agriculture and Fisheries, Department of Agriculture for Scotland, Ministry of Agriculture for Northern Ireland, Agricultural Research Council, Colonial Office. Association of British Insecticide Manufacturers, British Agricultural Contractors Association, National Association of Corn and Agricultural Merchants, and the National Farmers' Union, at the Majestic Hotel, Harrogate)—British Weed Control Conference 1954.

Wednesday, November 3

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. Shirley: "The Disturbed Strata on the Fox Earth Coal and its Equivalents in the East Pennine Coalfield"; Mr. D. A. Bassett: "The Silurian Rocks of the Talerddig District, Montgomeryshire".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. G. E. P. Box and Mr. S. L. Andersen: "Permutation Theory in the Derivation of Robust Criteria and the Study of Departures from Assumption".

SOCIETY FOR ANALYTICAL CHEMISTRY. BIOLOGICAL METHODS GROUP (in the Meeting Room of the Chemical Society, Burlington House, Piccadilly, London, W.1) at 6.45 p.m.—Meeting on "The Biological Evaluation of the Purity of Water and Effluents".

Thursday, November 4

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. D. McKie: "French Contributions to Science".*

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. B. B. Boycott and Prof. J. Z. Young, F.R.S.: "A Memory System in *Octopus vulgaris* Lamarck"; Mr. G. Hoyle: "Neuromuscular Mechanisms of a Locust Skeletal Muscle".

MINERALOGICAL SOCIETY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. M. J. Kelley, Sir Gordon Radley, Mr. G. W. Gilman and Mr. R. J. Halsey: "A Trans-Atlantic Telephone Cable".

RESEARCH DEFENCE SOCIETY (in the Physiology Lecture Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Sir Geoffrey Jefferson, C.B.E., F.R.S.: "Man as an Experimental Animal".*

UNIVERSITY OF LONDON, BRITISH POSTGRADUATE MEDICAL FOUNDATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. W. T. J. Morgan: "The Chemical Basis of Blood Group Specificity in Man". (From a series of lectures on "The Scientific Basis of Medicine".)*

INSTITUTE OF METALS, LONDON LOCAL SECTION (at the Royal School of Mines, South Kensington, London, S.W.7), at 7 p.m.—Prof. A. G. Quarrell: "Trends in Metallurgy".

CHEMICAL SOCIETY (in the Large Chemistry Lecture Theatre, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 7.30 p.m.—Prof. J. A. Christiansen: "On Open and Closed Sequences in Reaction Kinetics".

Friday, November 5

PHYSICAL SOCIETY (in the Lecture Room, Royal Astronomical Society, Burlington House, London, W.1), at 5 p.m.—Prof. A. C. B. Lovell: "The Development and Use of Large Radio Telescopes" (Duddell Lecture); Dr. J. S. Courtney-Pratt: "Some New Methods of Fast Photography" (Charles Vernon Boys Lecture).

Saturday, November 6

ASSOCIATION OF SCHOOL NATURAL HISTORY SOCIETIES (in the Lecture Hall, British Museum (Natural History), Cromwell Road, London, S.W.7), at 11 a.m.—Annual Exhibition.*

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. H. St. George Gray: "The Lake Villages of Somerset (Glastonbury and Meare)".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER (with a degree in agriculture or equivalent qualification, and with sound experience in practical work) IN AGRICULTURE, at the Cumberland and Westmorland Farm School, Newton Rigg, near Penrith—The Director of Education, 5 Portland Square, Carlisle (November 3).

LECTURER (preferably with experience in soil mechanics and geology) IN ENGINEERING, at Constantine Technical College, Middlesbrough—The Director of Education, Middlesbrough Education Committee, Woodlands Road, Middlesbrough (November 3).

LECTURER (woman) IN BIOLOGY, at Manchester Training College—The Chief Education Officer (S3/L), P.O. Box 480, Education Offices, Manchester (November 4).

ASSISTANT, Grade A (with graduate or equivalent qualifications), at the College of Commerce and Technology, Sheffield, to teach physics in national certificate courses in chemistry and metallurgy, in advanced level classes for the general certificate of education, and in various City and Guilds courses—The Director of Education, P.O. Box 67, Leopold Street, Sheffield 1 (November 6).

SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (qualified bacteriologist or chemist with sound bacteriological training) for work on disinfection involving a study of chemical sterilizers, including methods of laboratory evaluation—The Secretary, National Institute for Research in Dairying, Shinfield, near Reading, quoting 54/6 (November 6).

TECHNICIAN (preferably with photographic experience) IN THE ZOOLOGY DEPARTMENT—The Registrar, University College of Wales, Aberystwyth (November 6).

RESEARCH STUDENT (with the B.Sc. (Special Chemistry) degree of the University of London) IN CHEMISTRY—The Principal, Brighton Technical College, Brighton (November 8).

LECTURER (with a degree and/or other recognized professional qualification, and advanced knowledge of some branch of thermodynamics or gas dynamics, and of the theory and performance of propulsion units, and some practical experience of one or more modern propulsion systems) IN THE DEPARTMENT OF AIRCRAFT PROPULSION—The Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks (November 12).

DEMONSTRATOR (with special qualifications and interests in mineralogy and petrology) IN THE GEOLOGY DEPARTMENT—The Registrar, University College of North Staffordshire, Keele, Staffs (November 13).

ASSISTANT (preferably with qualifications in ecology or mycology) IN BOTANY—Joint Clerk to the University Court, Queen's College, Dundee (November 15).

HEAD OF THE DEPARTMENT OF AGRICULTURE, SENIOR LECTURER IN TROPICAL AGRICULTURE, LECTURER (Grade A) IN ANIMAL HUSBANDRY, LECTURER (Grade B) IN HORTICULTURE, LECTURER (Grade B) IN WORKSHOP PRACTICE (Agricultural), and FARM MANAGER, at the Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (November 15).

COAL SURVEY OFFICER (with a good honours degree or equivalent in a science subject, preferably with a sound background in geology and chemistry), in the Ayrshire Coalfield of Scotland, for work which will involve a detailed study of the structure and physical and chemical properties of the coal seams of the area—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/860 (November 16).

LECTURER IN CHEMISTRY—The Principal, University College, Galway, Ireland (November 19).

LECTURER IN ANATOMY AND HISTOLOGY—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (November 20).

LECTURER (preferably with palæontological research and field experience) IN GEOLOGY, at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, November 19).

LECTURER IN THE DEPARTMENT OF PATHOLOGY—The Registrar, The University, Leeds 2 (November 20).

PHYSICIST, BIOPHYSICIST or PHYSICAL CHEMIST, Senior Research Officer or Research Officer grade (with a university honours degree in science with physics or chemistry as a major subject, or equivalent qualifications) IN THE BIOCHEMISTRY UNIT, Wool Textile Research Laboratories, Commonwealth Scientific and Industrial Research Organization, Parkville, Melbourne, Victoria, to participate in an

extensive research programme concerned with the structure of fibrous proteins, polypeptides and related compounds by X-ray, infra-red and optical techniques—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 462/51 (November 20).

University Lecturer (preferably with veterinary or medical qualifications) in the Department of Animal Pathology, to undertake teaching and research in metabolic and nutritional diseases—The Secretary, Appointments Committee of the Faculty of Biology "B", Department of Pathology, University of Cambridge, Tennis Court Road, Cambridge (November 20).

British Insulated Callender's Cables Ltd. Research Student (with a good honours degree in engineering or physics), for research into the mechanical properties of powdered materials in relation to their use as electrical insulators—The Registrar, King's College (University of London), Strand, London, W.C.2 (November 22).

Analyst in the Department of Agriculture to participate in a special research project—The Registrar, The University, Leeds 2 (November 30).

Chair of Aircraft Electrical and Electronic Engineering—The Principal, College of Aeronautics, Cranfield, Bletchley, Bucks (November 30).

Senior Lecturer in Organic Chemistry, and a Senior Lecturer (preferably with primary interest and experience in either the theory of machines or machine design) in Mechanical Engineering, at the University of Adelaide, Adelaide, South Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 30).

Professor of Physics at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 1).

Chair of Glass Technology—The Registrar, The University, Sheffield 10 (December 11).

Biometrician for duties which include the design of experiments in all phases of tobacco production, together with the analysis of data and related statistical practice—The Director, Tobacco Research Board of Southern Rhodesia, P.O. Box 1909, Salisbury, Southern Rhodesia (December 31).

Director (with high scientific attainments, preferably in fields related to soils or crops, combined with administrative experience involved in the organization and running of a research institute or university department, and preferably with experience of tropical conditions) of the East African Agriculture and Forestry Research Organization, Muguga, near Nairobi, Kenya—The Director of Recruitment (H.M. Oversea Civil Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.195/151/02 (December 31).

Medical Research Fellow (medical graduate with some experience and success in research), for investigations in some aspect of virology, bacteriology, hæmatology or histopathology—The Director, Institute of Medical and Veterinary Science, P.O. Box 14, Rundle Street, Adelaide, South Australia (December 31).

Assistant Lecturer in (Agricultural) Engineering—The Principal, Shuttleworth College, Old Warden Park, Beds.

Bradford Dyers' Association Research Fellow (with high qualifications in science), to undertake research in tinctorial chemistry, textile chemistry or an allied subject—The Principal, Technical College, Bradford 7.

Engineers, Chemical Engineers or Physicists (with a good university degree, and preferably with industrial experience), for training as Reactor Technologists—The United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, Lancs, quoting 694.

Graduate Chemist as technical assistant in the Patents Division—The Secretary, National Research Development Corporation, 1 Tilney Street, London, W.1.

Horticulturist (with a degree in horticulture or equivalent, and a working knowledge of fruit and vegetable crops, and preferably with experience of the marketing of perishable vegetable crops), to take charge of the Horticulture Section of the Department of Agriculture, Cyprus—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.63/17/05.

Librarian and Information Officer (graduate with library qualifications and experience)—The Director, Scott Polar Research Institute, Cambridge.

Radio Engineer (with experience of high-power broadcasting transmitting equipment, and preferably with an engineering degree or other professional qualification), to be responsible for the operation and maintenance of the 20 kW. and 1·25 kW. transmitters, and two 250-Watt R.C.A. transmitters of the Dar es Salaam Broadcasting Station—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.178/8/05.

Regional Trials Officer (with a degree in botany or agriculture or equivalent qualification, with practical experience in crop production)—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

Senior Scientific Officer (Operational Research) (with a first- or second-class honours degree in mathematics or physics or equivalent qualifications, and with at least three years postgraduate experience of industrial operational research), with the U.K. Atomic Energy Authority, Risley, to assist and advise operational research groups in the laboratories, particularly on the use of mathematical, especially statistical, methods, and to collaborate with these groups when their investigations cover fields outside the immediate scope of the work of their laboratories—The United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting 693.

Tea Officer (with a wide experience of all aspects of tea growing and manufacture under commercial conditions, and a thorough knowledge of the marketing of tea) in Mauritius, to implement plans for developing the tea industry, to advise planters and manufacturers on improved methods of production, and to take charge of the Tea Experiment Station and of any other Government plantations, and a Government Tea Factory, if and when constructed—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.63/52/05.

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National Union of Journalists. Freelance Directory, 1954. Pp. 56. (London: National Union of Journalists, 1954.) [178

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Ministry of Agriculture and Fisheries. Fishery Investigations, Series 2, Vol. 18, No. 5: Purification of Oysters in Simple Pits. By H. A. Cole. Pp. 12+4 plates. (London: H.M. Stationery Office, 1954.) 3*s*. net. [178

Working Out a Permanent Agriculture in Central Africa: Compost and Cultivation Replace Burning and Shifting. By N. H. Porritt. Pp. 8. (London: Soil Association, 1954.) [178

Rural Life Journal. Vol. 1, No. 1, August 1954. Pp. 12. (London: Institute of Rural Life at Home and Overseas, 1954.) 6*d*. [178

Ministry of Health. Reports on Public Health and Medical Subjects, No. 95: Mortality and Morbidity during the London Fog of December 1952. (Report of a Committee of Departmental Officers and Expert Advisers appointed by the Minister of Health.) Pp. iv+61. (London: H.M. Stationery Office, 1954.) 2*s*. 6*d*. net. [178

Privy Council. Medical Research Council Special Report Series, No. 286: The Separation of Protein Fractions from Human Plasma with Ether. By R. A. Kekwick and Margaret E. Mackay. Pp. vii+75+5 plates. (London: H.M. Stationery Office, 1954.) 6*s*. net. [178

Transactions of the Royal Society of Edinburgh. Vol. 62, Part 3, No. 16: Caradocian Trilobites from Mudstones at Craighead Quarry, near Girvan, Ayrshire. By Ronald Pearson Tripp. Pp. 655–694+4 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1954.) 13*s*. [178

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Deutschen Wetterdienst, Seewetteramt. Einzelveröffentlichungen Nr. 4: Klimatologie der Nordwesteuropäischen Gewässer. (In der Abteilung Maritime Meteorologie, bearbeitet unter Leitung von Prof. Dr. E. Kuhlbrodt.) Teil 1: Temperatur des Oberflächenwassers und Temperatur-Differenz Luft-Wasser. Bearbeiter Dr. H. J. Bullig und Dipl. Met. P. Bintig. Teil 2: Windverhältnisse. Bearbeiter Dr. H. Markgraf und Dipl. Met. P. Bintig. Pp. ii+59. (Hamburg: Deutscher Wetterdienst, 1954.) [98

United States Department of Commerce. National Bureau of Standards. Supplement to National Bureau of Standards Circular 509: Bibliography of Books and Published Reports on Gas Turbines. Jet Propulsion, and Rocket Power Plants, January 1950 through December 1953. By Ernest F. Flock and Carl Halpern. Pp. iv+110. (Washington, D.C.: Government Printing Office, 1954.) 50 cents. [128

United States Department of Agriculture. Leaflet No. 358: Powder-Post Beetles in Buildings: What to do About Them. Pp. 8. (Washington, D.C.: Government Printing Office, 1954.) 5 cents. [128

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